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OF

PHILADELPHIA.

1887.

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EDWARD J. NOLAN,
Recording Secretary.

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JANUARY 4, 1887.

Mr. THOMAS MEEHAN, Vice-President, in the chair.

Fifteen persons present.

A New Species of Catfish (*Ictalurus*).—Prof. ANGELO HEILPRIN described a species of catfish from Lake Okeechobee, Florida, which differed in several well-marked characters from the various other North American species that had hitherto been described. The species is most nearly related to *Ictalurus lacustris*, the "catfish of the lakes," which it generally resembles. The color over the greater part of the body is blue-black, varying to black on the back, and white on the ventral surface; the barbels of one of the inferior pairs are white, and nearly so in the second pair. The dorsal fin is situated nearer to the adipose fin than to the snout; humeral process moderately long, about one-half the length of the pectoral spine; tail deeply forked, the upper lobe barely longer than the lower one. Length of largest specimen caught, about 20 inches. It was proposed to name this species *Ictalurus Okeechobeensis*.

JANUARY 11.

The President, DR. JOS. LEIDY, in the chair.

Eighteen persons present.

Papers under the following titles were presented for publication: "Description of a new form of Bryozoa," by Dr. C. Rominger; "Notice of some Parasitic Worms," by Jos. Leidy, M. D.

JANUARY 18.

Mr. JOHN H. REDFIELD, in the chair.

Fourteen persons present.

A paper entitled "On new Generic Forms of Cretaceous Mollusca and their relation to other forms," by Dr. C. A. White, was presented for publication.

The following were ordered to be printed:—

DESCRIPTION OF A NEW FORM OF BRYOZOA.

BY DR. C. ROMINGER.

Patellipora stellata. Pl. I, fig. 10.

Saucer-shaped colonies attached to foreign bodies by a short, stout root-like stem. Under surface of colony covered by a dense, smooth epithecal crust. From the centre of the concave, terminal, discoid expansion diverge from 8 to 10 rounded, stout radial crests or bars, which, towards the margin of the disk, dilate wedge-like. Intervening between these radii are deep furrows, likewise dilating toward the margin. The outer half of each of these wedge-like bars is again divided into two branches by a furrow entering them from the margin and running into a point about half way from the centre. The surface of these forked radial bars is covered with from 3 to 4 longitudinal rows of small, round orifices, which make them resemble the poriferous side of a fenestelloid stem. These orifices dilate in the interior into flask-like cell-bags, which can be observed closely packed together, on the underside of the bars, if by accidental wearing the epithecal coating of the underside has been removed.

This peculiar Bryozoa was discovered by me in some drift-boulders at Ann Arbor, associated with characteristic corniferous limestone fossils, in silicified condition. Only three of them were found by me; the most perfect and largest one of them is represented in the figure.

DESCRIPTION OF PRIMORDIAL FOSSILS FROM MOUNT STEPHENS, N. W. TERRITORY OF CANADA.

BY DR. C. ROMINGER.

My friend, Mr. Otto Klotz, in charge of the Astronomical work of the Canada Dominion, while engaged with geodetic measurements accidentally discovered this very interesting locality, which furnishes an abundance of well-preserved primordial fossils, particularly Trilobites, imbedded within a dark gray slate rock, of about 300 or 400 feet in thickness. Above the slate succeeds a large series of dolomitic rock beds, and below a very large belt of quartzites crops out; although the immediate contact of the quartzite with the slate is not seen in the locality.' The specimens collected on this spot Mr. Klotz had the kindness to send to me. He gave others to the University of Michigan, his Alma Mater. Many of these fossils are remarkably well preserved, and nearly all of them are believed to be undescribed forms.

I have also to acknowledge here the liberality of Prof. A. Winchell, who allowed me the use of the specimens sent to the University. Among the collected fossils the most frequent form is an *Ogygia*, which, in honor of its discoverer, I propose to name

Ogygia Klotzi. Pl. I, fig. 1.

More than a dozen perfect specimens of it are on hand, the largest one of which measures 11 centimetres in length, by a width of 6 centimetres; others are smaller in all gradations down to a length of only 16 millimetres. One specimen, which is otherwise not perfect, has the head complete, with attached movable cheeks; in all the others the movable cheeks are missing.

The flat expanded specimens have suffered a degree of compression, as usually occurs with fossils preserved in a slate rock. In a general way the longitudinal diameters of the head, the thorax, and the pygidium are equal, but the latter is usually somewhat longer than either of the other body-divisions. The glabella is large, reaching almost the front margin, which projects as an elevated narrow rim.

The convexity of the glabella is only moderate, and the lateral furrows on it, three in number, are very shallow, often scarcely perceptible. Its sides are almost parallel, only slightly bulging

out near the centre; width of the glabella measured across the upper edge of the palpebral rim is ⅓ of the entire diameter of the head at this place. Fixed cheeks are rather broad, the reniform palpebral lobe is margined by a projecting rim, which rim is seen continued under the form of a low rounded ruga extending from the upper angle of the eyes obliquely inward and upward, so as to meet the glabella at the third anterior lateral furrow of it. The occipital furrow and its lateral continuation across the cheeks is well marked. The movable cheeks terminate backward in a long spine reaching down to the third thoracic segment.

The facial suture line terminates posteriorly near the genal angles, anteriorly it intersects the margin on both sides of the glabella, quite a distance off from it, about perpendicular above the eye rim.

Thoracic segments in all the specimens, small or large, eight. The gently curved scabre-like ribs abruptly taper backward into a short spinose apex. Their centre bears a rounded broad depression, somewhat diagônal to the axis of the rib, and bordered on both sides by a projecting rounded ruga of which the anterior is more conspicuous than the posterior. The rachis is moderately convex, gently tapering backward; its width, compared with the length of the ribs, is as one and one-half to two in proportion. The pygidium, as above stated, exceeds the head or thorax slightly in length; it bears in the larger specimens eleven well-marked annulations, flanked by as many costal expansions which dilate considerably toward the margin, and bear in place of the central depression of the free ribs a rounded central ruga bordered on each side by a furrow; the edges of the anchylosed ribs are likewise indicated by an elevated rim.

The curvature of the pygidial ribs is much stronger than on the thorax, and their position to the rachis is more oblique, gradually increasing backwards, so that the hinder ribs of the pygidium meet the rachis under an acute angle. The edge of the pygidium is formed by a smooth convex rim, against which the costal rugæ abut.

In the figured specimen the movable cheeks were missing, and have been restored from another specimen with the head perfect.

Ogygia serrata. nov. sp Pl. I, figs. 2, 2*a*.

There are four complete specimens in the collection, besides numerous fragmental ones; nearly all are about equal in size; the

figured specimen is seven centimetres long, and five centimetres wide, measuring from one genal spine to the other.

Head, thorax, and pygidium of equal length.

General form of the head and course of the facial sutures correspond almost completely with the previously described species. The glabella of this form is somewhat broader and more prominent than in the former; also the glabellar furrows are more distinctly marked; they are three in number, the hinder one is the largest, directed obliquely inward and backward, but not reaching to the centre of the glabella.

The palpebral rim and the rugosity continued from it upward across the fixed cheeks are the same as in the former species.

The movable cheeks are protracted into long slender spines, which reach as far down as the fifth thoracic rib.

Rachis broad, almost equal in diameter with the length of the corresponding ribs, deducting their spiniform prolongations. The occipital ring terminates with a triangular monticulose prominence, overlapping the first thoracic ring, and likewise each one of all these annuli of the thorax, and the pygidium bears a strong spine on the median line.

The thorax of this species is, in all the specimens examined, composed of only seven segments.

The pygidium has five annulations with as many ribs corresponding to them. These ribs dilate considerably toward the margin, as in the former; but while in that, a smooth rounded rim edges the pygidium, in this form the principal ruga of each rib extends beyond the margin of the pygidium under the form of a strong acute spine, directed backward, so as to be almost parallel with the axis of the body. Five of such spines fringe each side of the pygidium; their size is gradually diminished toward the posterior end.

The hypostoma is in most of the specimens preserved, occupying its natural position. The shape is represented by one of the annexed figures and needs therefore no further verbal description.

Many loose, but much smaller hypostomas, of which I likewise figure a few (Pl. I, figs. 2*b* and 2*c*), were found scattered through the slate rock; to which of the associated trilobitic forms they belong, I was unable to ascertain.

Two other forms of Trilobites occur with the just described Ogygias, which in the configuration of their heads and in the

course of the facial suture lines fully correspond with them, but they differ by the much smaller size of their pygidia in comparison with the size of the concerned thoracic divisions and the heads. A further difference is in the number of thoracic segments, which in them is nine instead of eight, and seven, as in the two first described typical forms of *Ogygia*.

The glabella of the latter also shows three lateral furrows, while in the two forms to be described, four very well marked glabellar furrows are observable.

These differences and principally the difference in the proportion of the size of head, thorax and pygidium, appear to me sufficient to distinguish these forms from the genus *Ogygia*, and I propose to apply to them the generic name *Embolimus*.

Embolimus spinosa, nov. sp. Pl. I, fig. 3.

Only one, almost perfect specimen of this form is in the collection, but the number of fragmental specimens observable in the slabs prove that this is not a rare species.

The specimen figured is 34 millimetres long; length of head 14 millimetres; length of thorax 15 millimetres; length of pygidium 5 millimetres, without counting the length of spinous processes.

The glabella is large, moderately convex, of equal width in all its length, reaching close to the front margin, which is formed by a narrow upturned rim.

The four glabellar furrows are well developed, none reaches the centre of the glabella, the hinder ones are the largest, running obliquely backward, the second and third furrows extend almost at right angles from the margin of the glabella, but the apex of the second is turned backward while the apex of the third furrow is curved forward. The fourth and smallest furrow is directed obliquely forward.

The occipital ring forms a triangular projection of the posterior margin, which is crowned with a stout short spine, also each of the thoracic annuli exhibits a faint indication of former ornamentation by a spine which is broken off in the specimen.

The pygidium has four sharp annulations with as many costal appendages, which, a short distance off from the rachis, are abruptly bent backward, tapering into long spines projecting over the pygidial margin in a direction parallel with the longitudinal axis of the body.

Also the thoracic ribs terminate with long spines directed obliquely backward. Each rib bears a deep depression in the central part, which, commencing near the spinose peripheral end, runs diagonally across the broader part of the ribs meeting the rachis near the upper end of each annulation; but previous to that, this depression sends off a side branch backward, which meets the posterior part of the same annulus, leaving between the two depressions a pointed triangular elevation in continuity with the convex portion of the annuli; the edges of the ribs project as elevated rounded rims, broadest in the middle, and tapering toward the rachis and toward the periphery, where the anterior rim is seen to constitute the body of the projecting spines.

Embolimus rotundata, nov. sp. Pl. I, figs. 4 and 5.

There is only one specimen in the collection which shows head, thorax and pygidium in connection, but the movable cheeks are missing. Other fragmentary specimens, however, exhibit the head complete. The proportions in the size of the three partitions of the body are:

Head, 13 millimetres; thorax, 14 millimetres; pygidium, 9 millimetres. Nine thoracic ribs, as in the former species; the pygidium has six well-marked annulations and corresponding pleural expansions, margin rounded, no spinose projections. The thoracic ribs are similar in configuration with those of the preceding species, but they terminate rather abruptly with short pointed ends.

The head likewise closely resembles the former species, with the difference that the glabella expands considerably toward the front end, while the glabella of the former is all its length of equal width. The movable cheeks, observable in one of the specimens, terminate backward in a long spine, reaching as far as the fourth thoracic articulation. The two figures represent a fragment with complete head and another incomplete specimen with the movable cheeks missing.

Monocephalus Salteri ? Billings. Pl. I, fig. 6.

I have, with some doubt, identified a small specimen found in association with the others with the form described by Billings under this name. The minuteness of the fossil, and its being merely a cast without shell, prevents the observation of the more delicate structural details, but the general appearance of Billings' figure, as well as his description, are satisfactory proof to me that

both fossils under consideration must be closely related, if not identical.

The specimen, of which a figure is subjoined, has a total length of 16 millimetres; length of head, 6 millimetres; length of thorax with *seven segments*, also 6 millimetres; length of pygidium, 4 millimetres.

The head of the specimen, deprived of the movable cheeks, bears a large glabella considerably dilating in front, with three distinct lateral furrows. The thoracic ribs are deeply excavated in the centre, and the adjoining margins of every rib project as high ridges with a dividing line along the crest. The annuli composing the pygidium are rather obsolete, but four sharp furrows, spreading from each side of the rachis, indicate its composition of at least four anchylosed segments.

Conocephalites cordilleræ, nov. sp. Pl. I, fig. 7.

Numerous specimens of this little trilobite occur in the collection; their average size in length is about 25 millimetres; the movable cheeks of the specimens are generally missing, otherwise the bodies are usually perfect.

Glabella conical, convex, provided with three lateral furrows, of which the posterior is the largest, quite oblique; occipital furrow deep. The glabella in its extension towards the front varies some, as between it and the upturned projecting rim of the front a broader or narrower strip of the fixed cheeks intervenes. The fixed cheeks are broad, margined with a small reniform burrelet at the palpebral angle of the facial line, and from the anterior end of this eye-rim a faint rugosity is seen to run across the fixed cheeks, toward the front part of the glabella, near its anterior sulcus.

Rachis uniformly tapering toward the tail-end, consisting in the thoracic part of seventeen segments, in the majority of specimens examined; but in one, evidently belonging to the same species, I counted only fourteen, and in another fifteen. The ribs are pretty straight, with a deep central depression and high projecting marginal rims, which are joining the rims of the neighboring ribs in a sharp linear groove. Each annulus of the rachis at its juncture with the ribs is decorated with a rounded node.

The entire surface of the body appears, in well-preserved specimens, covered with delicate papilli and granules.

The pygidium is very small, but clearly composed of at least three anchylosed segments.

Bathyurus? Pl. I, fig. 8.

A single specimen in the collection, or rather an impression of one, from which I prepared a gutta-percha cast, leaves me in doubt in regard to its generic affinities.

The smooth, rather convex glabella, without indentation by lateral furrows and the shape of the facial suture lines, resemble some forms described by Billings under the name *Bathyurus;* also the configuration of the other parts of the body would agree with these, but the number of thoracic segments in the specimen under observation is only six, while nine are claimed for *Bathyurus.* Not considering the material on hand as sufficient to decide whether this is a new generic type, or might be a form of *Bathyurus* with a normal number of thoracic segments, of which some became hidden by being shoved under the head, I content myself for the present by giving an exact copy of the gutta-percha cast formed in the impression of the slate-rock.

Agnostus. Pl. I, fig. 9. Compare *A. integer* Barr.

Many of these minute crustaceans are found scattered on the slabs of slate. They all apparently belong to one species.

The anterior valve differs from the posterior by the conical shape of its glabella terminating near the front margin in a bluntly pointed end; the median line of this glabella rises near the posterior end into a root-like crest, terminating in a backward projecting spinose protuberance; the posterior part of the glabella exhibits also an indentation by lateral furrows.

The rachis or central convex protuberance of the posterior valves is equilateral and not conical; the posterior end of it it abruptly rounded off; a deep furrow runs across this central protuberance on the posterior third of it; its larger anterior portion bears a short spinose projection.

The two thoracic annuli are divided by furrows and constrictions into nodular partitions representing rachis and ribs, but of too small a size to be accurately represented by a description, or by figures. The subjoined figure of one of the specimens is enlarged three diameters.

Besides the described crustaceans, the slates inclose also numerous minute Brachiopods, several of which belong to the genus *Obolella.* One of these Obolellas, almost circular in outline, with

marginal umbo, exhibits most delicate concentric lines of growth with ruffled edges, in addition to which also faint radial striæ emanating from the umbo are observable.

Other similarly rounded specimens of *Obolella* show fine concentric striation, but in comparison with the former may be considered smooth. Also more oval-shaped specimens of *Obolella* occur.

The genns *Orthis*, in a form similar to *Orthis pepinensis* is likewise represented; another form resembles *Kutorgina sculptilis* Meek. Small shells of the shape of *Leptæna* are also found, and one specimen similar to *Metoptoma*.

Some slender stems, consisting of shining carbonaceous matter, seem to belong to Grapholites. Finally I have to mention yet the occurrence of a form of *Theca* or *Hyolites*, of the same appearance as *Theca primordialis* figured by Hall. As I intend to examine this locality myself, as soon as the season allows, I expect to be able to give before long a more complete exhibition of the fauna inclosed within these slate-rocks.

NOTICE OF SOME PARASITIC WORMS.

BY JOSEPH LEIDY, M. D.

Filaria megacantha.

Body straight, nearly uniform cylindrical, slightly narrowed posteriorly, obtuse at the ends, milk-white in color; head rounded; mouth bounded by a pair of prominent papillate lips. *Female:* caudal extremity straight, obtusely rounded, smooth, without anal aperture. *Male:* caudal extremity conical, obtuse, bialate; alæ narrow, united around the end of the tail, together forming a shallow pouch, with a row on each side of six rib-like papillæ, of which four are in advance and two behind the genital aperture. A long, curved and partially exserted penal spiculum and a nearly straight short one.

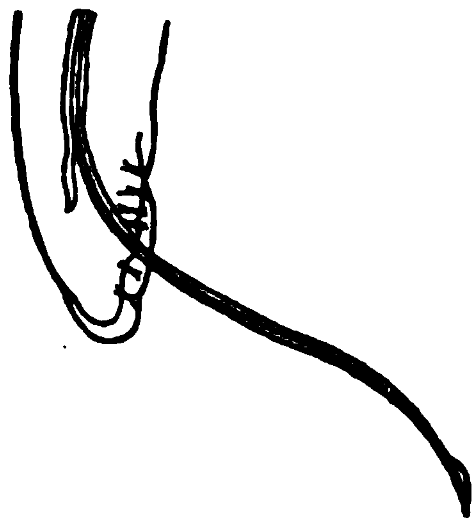

FIG. 1.—Side view of caudal extremity of the male, highly magnified.

Eight females, 35 to 60 mm. long; cephalic extremity a short distance back, 0·75 wide; body at middle, 0·625; near the tail end the same width. Seven males, 20 to 25 mm. long; cephalic extremity, 0·375 wide; body at middle, 0·5; near tail end, 0·25 wide. Large penal spiculum, 2·5 to 3 mm. long; shorter one, 0·18 to 0·22 mm.; caudal bursa, 0·28 long; width of alæ, 0·036 mm.

From the subcutaneous connective tissue of the neck and mandible of the Short-eared Owl, *Asio occipitrinus* (*Strix brachyotus*).

This appears to be a much smaller and different species from the *Filaria attenuata* Rud., found in the same bird and others of the order in Europe. Dujardin [1] gives as the size of the latter 250 to 308 mm. for the female, and 136 to 148 mm. for the male, with 1 mm. for the longer penal spiculum. Schneider [2] gives for *F. attenuata*, from *Falco peregrinus*, 330 mm. for the female, and 115 mm. for the male, the caudal bursa of which he represents as circular. He remarks that the Filaria of Strix and of *Cecus glandarius*, referred by Rudolphi to *F. attenuata*, is a different species, but does not describe it, for want of perfect specimens.

[1] Helminthes, 51. [2] Monog. Nemat., 89.

Obtained in Chester Co., Pa., December, 1886, by Dr. B. H. Warren.

Three specimens, females, two inches in length, from the orbit of the Hen-hawk, *Buteo borealis*, in the collection of the Army Medical Museum, appear to belong to this species.

Ascaris tulura.

Body cylindrical, most narrowed and tapering anteriorly, of a pinkish color; mouth trilobed, the lobes together nearly as wide as the head. *Female:* caudal extremity nearly as thick as the middle of the body, straight; tail short, obtusely conical, as broad at base as the length. *Male:* caudal extremity tapering, slightly incurved, with a row on each side of minute papillæ (20 or more?); tail short, conical, ending in a spheroidal knob.

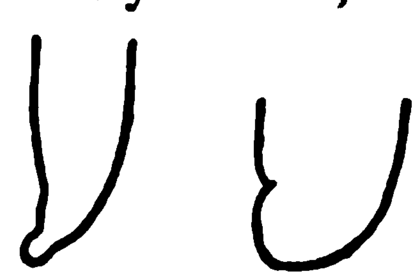
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FIG. 2.—Caudal extremity of female; 3. Of male. Highly magnified.

One female; length 125 mm.; width of cephalic extremity a short distance from the end, 0·375; at middle of body, 1·25; near the tail, 1 mm. wide; tail, 0·25 long. One male; length 90 mm.; width at middle, 0·75; tail, 0·25 long; rounded end, 0·125 thick.

From the ventriculus of the Red-shouldered Hawk, *Buteo lineatus.*

This worm approximates the *Ascaris depressa* Rud., observed in many rapacious birds, but appears to be a different species. Diesing[1] describes the tail of the male of the former as shortly mucronate and papillose beneath, and Schneider[2] figures it according to that description.

Specimens obtained in Chester Co., Pa., December, 1886, by Dr. B. H. Warren.

Ascaris sulcata Rudolphi.

Body anteriorly attenuated; posteriorly more or less closely spiral; head with prominent lips. *Female:* tail conical, recurved from the anus, ending in a minute mucro. *Male:* tail conical, shortly mucronate, bialate, with a row on each side of four or five nipple-like papillæ.

Female, up to 25 mm. long by 0·5 wide at middle; tail, 0·25 long. Male, 15 mm. long by 0·3 wide at middle,

[1] Syst. Helm., 156.

[2] Monog. Nemat., 41.

Numerous specimens were found tightly clinging by the mouth to the lining membrane of the stomach of *Trachemys scabra.*

Echinorhynchus caudatus Zeder.

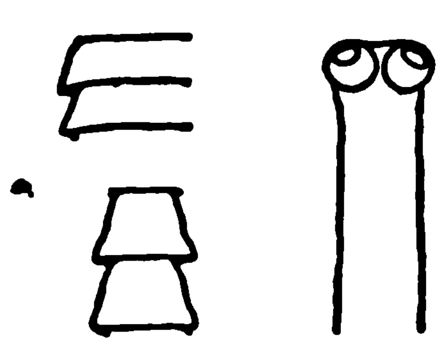
Body narrow, cylindrical, nearly equal throughout, strongly corrugated so as to appear annulated, posterior extremity conical. Proboscis cylindrical, expanded at base, with 9 to 11 rows of strong hooks, succeeded with about 15 rows of smaller hooks. Length, from 5 lines to an inch; breadth, 0·5 to 1·5 mm. From two individuals of the Swallow-tailed Kite, *Elanoides furcatus,* in one of which they were associated with *Tænia viator.* Two specimens from *Strix nebulosa.* Florida. Dr. B. H. Warren.

Echinorhynchus hystrix Bremser.

Body cylindrical, much corrugated, widest anteriorly and minutely echinate. Proboscis clavate, with about a dozen rows of hooks. One-fourth to three-fourths of an inch long and one line wide at the fore part. Numerous specimens from the intestine of the Darter, *Plotus anhinga.* Florida. Dr. B. H. Warren.

Tænia simplicissima.

Head small, unarmed, truncate; bothria spherical, terminal, occupying the four angles; neck very long, nearly or as wide as the head, body gradually widening to the posterior third and then tapering; anterior segments transversely linear, subsequently reversed dish-like, gradually longer and wider, then campanulate and gradually becoming longer and narrower. Generative apertures and ova unobserved. A number of specimens from the Cod, *Gadus callarias,* up to 20 lines by 1 mm. where widest. Two only of the specimens retained the head.



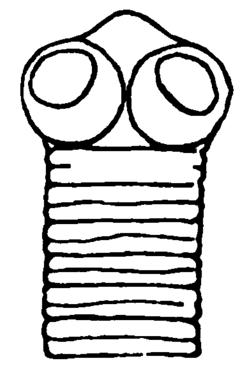
5, 6. 4.

FIG. 4. Cephalic extremity; 5. Segments about middle; 6 Posterior segments. Magnified 20 diameters.

Tænia Amblopliti̇s.

Head quadrate, spheroidal, consisting almost entirely of the four large spherical bothria, with the summit slightly prominent and conical or depressed and unarmed; neck very short or none; body compressed cylindrical, gradually widening from the head to near the posterior part where it slightly narrows to the end; segments linear, becoming gradually longer and wider, and then more quadrate; all deeply and pretty regularly wrinkled into

two or three annuli. Genital apertures obscure. Length 8 to 12 inches; in alcohol contracted to 3½ to 5 inches; greatest width 2 mm.



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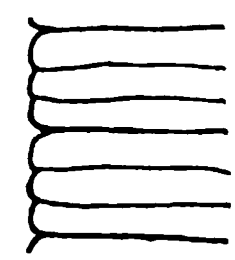

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FIG. 7. Cephalic extremity; 8. Segments near middle. 20 diameters.

Head 0·5 to 0·625 mm. long, and 0·75 to 0·875 broad. Bothria 0·375 mm. diameter. Commencement of body 0·625 wide. Anterior segments 0·125 long, 0·625 wide; subsequently 0·375 long and 1·5 to 1·875 wide; posterior segments 0·75 long by 1 mm. wide.

A number of specimens from the stomach of the Rock Bass, *Ambloplites rupestris*. Lake George, New York.

This species resembles the *Tænia ocellata* Rudolphi of the European Perch, *Perca fluviatilis*, and perhaps is the same.

Tænia Micropteri.

Head large, compressed spheroidal, with four subterminal spherical bothria and a papilliform unarmed summit; neck none; body obscurely segmented, and with no obvious internal organs, posteriorly variably narrowed and obtusely rounded at the end. Length from half an inch to an inch, and about 1 mm. wide. Apparently a larval form; found in the body cavity of the Black Bass, *Micropterus nigricans*. Six worms, soft, white, and active. The longer ones of an inch would elongate to double the length, becoming proportionately narrower. The head, about 1 mm. or more in diameter, varied in length and breadth, according to contraction, sometimes one and sometimes the other being the larger. Lake George, N. Y.

Last summer, while at Mt. Desert, Me., I examined a squid, *Ommastrephes illecebrosa*, with the hope of finding the singular parasite *Dicyema*. The specimen was in bad condition, and while I found none of the latter, I obtained from it several small worms, which I suppose to be the larval form of a cestode. They were yet quite active, though the host was already putrescent. I suspected them to belong to *Tetrabothriorhynchus migratorius*, observed in European cephalopods, but examination showed them to be different. They moved so actively and incessantly, contracting, expanding and writhing, that it was difficult to obtain a clear idea of the shape of the worm. It appears most nearly related with *Tænia*, and provisionally may be regarded as a

larval form of this genus. Its more evident characters may be summed up as follows:

Tænia loliginis.

Head unarmed, without rostellum, quadrilobate, continuous with the neck, which is variably long and narrow or short and irregularly contracted and expanded, and is constricted from the body. Lobes of the head elliptical, contractile and expansile and becoming variably folded or corrugated, furnished each at the upper pole with a hemispherical bothria. Body about as long as the head and neck, extensile and contractile, obconic or obovate, compressed, acute posteriorly, unsegmented. No interior organs visible except a vessel along the sides of the neck and encircling the lobes of the head. Color white. Length to about half an inch; width about 1 mm. Dr. H. C. Chapman informed me that he had previously observed this parasite in the squid.

Monostomum obscurum.

Elongated elliptical, flattened, obtusely angular in front, obtusely rounded behind. Oral and genital or other apertures scarcely distinguishable. Length, 4 to 8 lines; width 1 line.

Numerous specimens in the stomach of a Jew-fish, *Megalops thrissoides*. Collection of the Army Medical Museum, Washington.

Distomum Aquilæ.

Spatulate, cochleariform, widest behind, obtuse at both ends; mouth circular unarmed; acetabulum sessile, about as large as the mouth. Length, 3 lines; width in front, ½ a line; behind, ¾ of a line. Two specimens from the trachea of the Bald Eagle, *Haliætus leucocephalus*. Collection of the Army Medical Meseum.

Distomum hispidum Abildgaard.

Body much attenuated in advance, covered with minute recurved spines, which become obsolete at the back part. Head with a pair of alate appendages covered with stronger recurved spines, and a small group in the intervals before and behind. Mass of eggs giving the axis of the body behind a red appearance. Ova oval, 00·4 mm. long, 00·24 mm. broad.

Numerous specimens, about 4 lines long by 0·5 mm. where widest behind. From the intestine of the Sturgeon, *Accipenser sturio*, of the Delaware River, at Philadelphia.

Nitzschia elegans Baer.

Several specimens of this leech, four lines long, were taken from the gills of the same sturgeon.

JANUARY 25.

REV. HENRY C. MCCOOK, D. D., Vice-President, in the chair.

Twenty-one persons present.

The following were elected members; Bernard Persh, Geo. B. Cresson, Joseph Whitehouse, William B. Marshall and William Osler, M. D.

On a Tumor in the Oyster.—Prof. JOHN A. RYDER remarked that a few days since Professor Leidy handed him the soft parts of an oyster, which he said he thought might be an interesting subject for investigation, inasmuch as a very large tumor had grown into the pericardiac cavity. The specimen is a very remarkable one, and seems to be the first of the kind which has fallen under the observation of naturalists; neither Professor Leidy nor the speaker, in the course of large opportunities for observation, having previously encountered anything of the sort. It is also of great interest as proving that such pathological growths may be developed in the mollusca, thus showing that even in the invertebrata there may be morbid proliferations of certain tissues which simulate in certain respects those observed to occur in man and the higher types of vertebrates, in which they become very dangerous and painful in character, as in the case of cancer.

The first and most striking features of this tumor, found in the oyster, is its great size in proportion to that of the animal. The tumor in its largest dimension measures nearly one inch across, with a thickness of fully half an inch. The total length of the animal, in alcohol, is about three inches, and it appears normal in every other respect. For size, in proportion to the dimensions of the animal, it can therefore only be compared to those huge morbid growths on certain parts of man known as elephantiasis. It is subcircular in outline as viewed from the side, and fills up the pericardiac cavity in front of the adductor muscle; this cavity being very greatly enlarged in consequence of the growth of the tumor. The larger portion of it also lies on the right side, and on account of its great size it has displaced the heart forwards and to the left.

Its consistence is soft and yielding when pressed with the finger, and consists of some eighteen very distinct lobules of irregular size and form. Its joint of attachment appears to be to the mass of tissue which surrounds the posterior and rectal part of the intestine of the animal, and appears to have grown out in this region, or from the dorsal wall of the heart chamber.

Upon removing one of the lobules, which was cut into sections, it was found that its histological structure was also very remark-

able, and considerably different from that of the normal tissue of the body-mass of the animal. The sections also showed that the tumor was traversed by vessels, the tissues immediately around which were more nearly of the kind normally found to constitute the greater part of the substance of the body-mass. The normal connective tissue is composed of large cells or spaces with thin walls, and about the centre of each one of these a small, complex mass of protoplasm is found which is suspended to the sides of its vesicular wall by means of fine radiating protoplasmic threads or filaments. Very minute nucleated and rounded blood and lymph cells are also found in the general connective tissue of the body-mass in small numbers.

The histological structure of the tumor contrasts with the normal tissue in the following particulars. We find no evidence of the presence of the central protoplasmic bodies, with radiating processes, in the meshes of the tissue. The mesh of the tissue of the tumor is areolar, or alveolar, the alveoli being much larger than the vesicular cells of the normal connective tissue. While there is a complete absence of the protoplasmic bodies with filaments, the alveoli contain great numbers of very small globular, nucleated cells, somewhat variable in size. These cells closely resemble the colorless blood and lymph cells of the oyster, and some show processes or pseudopods. They are generally adherent to the walls of the alveoli, or project in small adherent clumps from the parietes of the alveoli and never completely fill the meshes of the alveolar tissue, in which they are included, as do the analogous cells in the alveoli of tumors in the higher animals.

Near the centre of each nodule there is a zone of alveoli which are larger, and in which the small rounded cells are most abundant. At the surface of the tumor there is no investment of a truly integumentary character, so that the proliferating mass seems to have ruptured the integument or membrane lining the pericardium. At the surface we therefore find that there is no true integument, but instead, the alveoli become smaller and more compact, with the contained small rounded cells more closely packed. The tissues of the tumor are entirely of mesodermal origin, and are therefore of considerable interest from the standpoint of comparative pathology.

The speaker also referred to the presence of tumors, which developed as outgrowths of the intestinal wall, near the pylorus, in the common shad, and also instanced the occurrence of profound lesions of the Wolffian body or kidney of the common gold-fish, as a result of which that organ underwent complete degeneration, with other changes which caused a bloated, dropsical appearence in the cavity of the abdomen. Large meshes of fibrous tissue were, in fact, found occupying the place of the kidney filled with a watery or colloid substance, the whole taking up a much greater space than that originally filled by the normal organ. These data, the speaker thought, were very significant,

as showing that even the lower animals were not exempt from morbid growths and lesions of the most serious character. Tumors of the kind described in the oyster are probably very rare, however, and the speaker considered that it was very fortunate that the specimen had fallen into the hands of a naturalist, such as Professor Leidy, who could so well appreciate its importance and value. The tumor seems to have been benign in character, as the oyster in other respects appears to have been healthy. It was also localized, and did not appear in other parts of the animal, so that it was probably in no way infectious.

Modification of Habit in Ants through fear of Enemies.—Dr. HENRY C. McCOOK described a raid of the Sanguine ants, *Formica sanguinea*, which occurred in a vacant lot at Asbury Park, N. J. The co-operative nest of the two species was established quite near the sidewalk, and the raid was directed thence into the open lot. The marching column of Sanguines was accompanied by a few individuals of the black slaves. What special purpose the latter had he was not able to determine. The eagerness exhibited by the Sanguines upon the march was very noticeable, although these creatures are always active in the nest and at any domestic labor as well as war, in which respect they differ largely from the shining slave makers, *Polyergus lucidus*.

On the occasion of which he spoke, the nest of Fuscous ants, *Formica fusca*, against which the expedition was directed, was concealed among a large amount of forest rubbish, such as bits of broken chips, twigs, dried leaves, etc., that were scattered over the barren space, interspersed here and there with tufts of grass and low huckleberry bushes. The invaders had evidently located the nest, but not with absolute accuracy; at least they were not able to determine the point at which it might successfully be assaulted. A most animated scene was presented over the entire surface, some three feet in diameter, upon which was concentrated the united energies of the warriors. Over and around this space in various lines the ants wandered, crossing and criss-crossing each other's pathways, sometimes singly, sometimes in couples or triplets, or in larger crowds, but always exhibiting an attitude of fevered eagerness, applying their mandibles and mouth-parts continually to the ground in search of the point of vantage which would give them ingress to the coveted treasures of the Fuscous ants.

A space about ten inches in diameter, strewn with dry chippage seemed to represent the locality beneath which the blacks had established their formicary. The Sanguines energetically pulled away the chips, scattered them here and there, burrowed lightly in the earth hoping to obtain an opening. About two feet distant from this point the speaker discovered a small round entrance or gate which was soon identified as one of the outer approaches to the Fuscous nest, for several of these ants were

seen issuing from the gate and others were hovering around it. At this moment one of the Sanguine army, in the spirit of a pioneer or scout, approached this point. Thereupon the blacks climbed up adjacent spears of grass, where they remained apparently on guard. After about ten minutes spent in the exploration which has been described, the reds began to drain off from the centre of search towards their home. In the meantime a considerable number of the Fuscas, who had evidently been out upon foraging expeditions and were homeward bound for the night, discovering the crowd of enemies who surrounded their borders, had discreetly taken refuge like their associates on the tufts of grass everywhere around the margin of the space within which the Sanguines had been operating.

Two of these blacks, more courageous or cunning than their associates, Dr. McCook observed to slip into a little opening and disappear inside. They were presently followed by several Sanguines, who, however, shortly returned from within and proceeded with their surface explorations, apparently having found no clew to the main formicary. The blacks, however, had certainly safely entered their home. He greatly wondered at this, and regarded it as an evidence of remarkable cunning and skill in strategy on the part of the Fuscas, which had enabled them thus so rapidly and easily to close the opening to their nest and throw the invaders off the scent.

An hour after the commencement of the raid not more than half a dozen of the Sanguines remained upon the scene, the rest of their company having abandoned the search for this time at least. This corporal's guard of persistent scouts also gave up the search at last and marched back home, the secretive skill of the blacks having thus far prevailed for the protection of their colony.

The interesting fact in the history of these curious creatures to which Dr. McCook wished to call especial attention is, that their instinct for kidnapping has appeared to develope on the part of those who are the victims of it a corresponding strengthening of instinct in the way of concealment. The Fuscous ants are ready enough to defend their homes with their lives and often do it successfully when their numbers are great enough to overcome the superior physical power and warlike skill of their enemies. But the weaker colonies of Fuscas must always yield to the prowess and strength of the Sanguines, unless their cunning can put their invaders at a disadvantage.

The case just mentioned does not stand alone. At various times when the speaker had observed these black ants in such site that they are exposed to the attacks of the Sanguines, he had noticed that their nests were constructed very differently from those of colonies in neighborhoods not infested by Sanguines. In the latter positions it is the habit of the Fuscas to raise above the surface of the ground a flattened moundlet, or sometimes a

mound of considerable size. Over the summit and at the base of these elevations are scattered the gates or openings into the galleries without the least attempt at concealment. The whole formicary shows that its inmates dwell in security without any fear of such special perils as those described. On the contrary, the Fuscous colonies established in the near vicinity of their hereditary foes have a marked tendency to omit or subdue elevations above the surface, the dumpage from interior galleries being apparently scattered broadcast instead of piled above the central formicary. Their gates are few and cunningly concealed, and quantities of rubbish are scattered around with the evident intention of hiding the locality of their nest or making the approach to it more difficult. It has thus come about with these unfortunate blacks, as is the case with the human species, that the difficulties of life and perils to person, offspring and home, have developed a higher order of protective instinct.

A similar faculty Dr. McCook had observed in the case of an amber-colored ant, the Schauffuss ant, *Formica schauffussi.* He was watching the assault of a colony of Sanguines upon a Fuscous nest in the grounds of his friend Mrs. Mary Treat, Vineland, N. J., when he chanced to see a solitary individual Schauffuss moving back and forwards a little distance from the scene of invasion. Knowing that this ant is sometimes enslaved by the Sanguines he directed his attention upon her and easily perceived that she was putting finishing touches upon the closure of a little hole that marked the gate of her formicary. A tiny pebble was placed, then a few pellets of soil were added. Next the worker walked away, took a few turns as though surveying the surroundings, and cautiously came back. The coast was clear. Now she deftly crawled into the small open space, and the observer could see from the movements inside, and occasional glimpses of the tip of her antennæ, that she was completing the work of concealment from the inside. At last her task was done and all was quiet. Just then a single Sanguine warrior, apparently a straggler from the invader's army near by, or some independent scout it may be, approached the spot. It walked around the nest, which was indistinguishable from the surrounding surface; sounded or felt here and there with its antennæ; passed over the very door into which the Schauffuss ant had disappeared, and although its suspicions were evidently strongly awakened, it at last moved away. The speaker felt satisfaction that the Sanguine depredator had thus been baffled and that the instinct of home protection had proved too much for the wretched kidnapping cunning. However, his pleasure was somewhat clouded by the reflection that the slave-making scout would probably be back before long, accompanied by the host of its fellows, and do its work more surely. But the impression remained strong upon his mind that the Schauffuss colonists, like the Fuscous ones above alluded to, had decidedly modified their habits of nest

architecture to meet the perils arising from close neighborhood to their kidnapping enemies.

Notes on the Geology of China.—Prof. Heilprin read from Miss Adele M. Fielde the following notes on the geology of south-eastern China, which are of interest, inasmuch as nothing on the physical features of that section of the empire has as yet been published.

"I have been on a trip up the Han River, 130 miles, to the Pass between the Kwangtung and Fokien Provinces. The mountains slope steeply down into the river on both its sides for eighty miles, and a narrow path runs on each slope parallel with the river at varying distances above it. Some of the mountains are probably three thousand feet high, and the ridges at a distance appear so narrow that a man might stride and sit on them as on a saddle. The river keeps a general trend southward, its bends being short ones. Its delta covers several square miles. In all the lower part of its course it is kept in its channel by dikes, as its sandy bed is higher than the adjoining rice fields. Just above the city of Chow-chow-fu, thirty-two miles to the north of Swatow, the mountains begin to rise, and they are, like those near Swatow, almost wholly of granite. This rock extends up to Liu Ng, a town twenty-four miles further up the river. Stone No. 1, in the box sent herewith, is a specimen of this outcrop near the river. Ten miles further up the granite becomes very coarse, as in No. 2. Ten miles still further, or twenty-six miles from the mouth, the outcrops are, for a short distance, of whitish sandstone, like No. 3, and these are immediately followed by red sandstones, Nos. 4 and 5, which continue in mountain after mountain, gorge after gorge, precipice after precipice, for some sixty miles. These are magnificent exposures, the stratification showing very plainly, with lines of cleavage nearly at right-angles to the lines of deposit. The inclination is at all angles, some being level, some vertical and some showing splendid curves. Here and there are to be found apparent injections of another stone, which, I fancy, may be trap No. 6. I also found some streaks of landscape-sandstone, No. 7. In one place I found a huge mass of the speckled stone, pink, with brown spots, marked No. 8, in the box. This, like all the other specimens, is a portion of the great outcrop from a mountain side.

"Red sandstone, in some places, almost like dark shale, in others very hard and of a light color, extends to within ten miles of the pass. Towards its upper boundary I noticed much inter-mixture with light sandstone, and with a greenish stone, No. 9. The stratification of the latter was very plain, and in places the mountain path leads over the edges of the strata as they stand perpendicularly. Near the pass and also through the pass (which is four miles long, and is a wild gorge through which the river flows in a white torrent), the outcrops and boulders are again

wholly of granite, like that of Liu Ng. Not far below the pass there had been a landslide from one of the mountains, and it gave a fine chance to see the original constitution of the slope. I suppose this sandstone may be Triassic, because it appears to be unfossiliferous. The Chinese do not make vast excavations, but they use stone for bridges, etc. In one place I crossed a new bridge, made of red sandstone, and I examined the quarry from which the stone came. If there were fossils found they would, without doubt, be used as fetiches, and I should hear of them. The natives said no queer thing had been found or seen in the stones. There was no sign or speck of a fossil to be found about the quarry."

The specimens of stone accompanying the notes were commented upon by Prof. Heilprin, who stated that they would be the subject of further study and report. The district here described is an interesting one to geologists, inasmuch as it had hitherto received but little attention upon the part of the travelers. Much of the rock surface is probably identical with that observed by Richthofen in the region to the west and north, the details of which have not yet been published in his work on China. The red sandstone (Nos. 4 and 5) described by Miss Fielde as a possible representative of the Trias, is apparently a member of the series referred by Richthofen to the Jurassic period—so identified by the plant remains.

Chinese Rhizopods.—MISS FIELDE also announced that during her study of the fresh-water Rhizopods found in the streams around Swatow, she had collected several forms identical with those described by Dr. Leidy, from the neighborhood of Philadelphia (*Difflugia urceolata, D. pyriformis, Arcella vulgaris*).

The following was ordered to be printed:—

ON NEW GENERIC FORMS OF CRETACEOUS MOLLUSCA AND THEIR RELATION TO OTHER FORMS.

BY CHARLES A. WHITE.

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The type species of the three generic forms which are described in this article [1] belong to the collections of Cretaceous fossils from Texas, which I am now preparing for publication in one of the memoirs of the U. S. Geological Survey. In their generic characteristics all three of them appear to be respectively identical with certain forms which have long been known, but which have been referred to other genera by different authors. The features which I now present as having generic value seem to have been overlooked by those authors, or, so far as they were observed, they were treated as specific characters. Two of these forms belong to the section Melininæ of the family Aviculidæ. The other is referred to the Crassatellidæ, but it departs considerably from the typical section of that family.

CRASSATELLIDÆ.

Genus **STEARNSIA** (gen. nov.).

Shell compressed, subtrihedral or subcircular in marginal outline; beaks small, closely approximate, prominent by reason of the abrupt sloping away of both the antero-and postero-dorsal borders; lunule and escutcheon both well defined and flattened or excavated; hinge strong, consisting of both cardinal and lateral teeth; cardinal teeth two in the left valve and three in the right; both posterior and anterior lateral teeth long aud slender; posterior laterals two in the right valve and one in the left; anterior laterals two in the left valve and one in the right. If, however, the overlapping border of the right valve and the entering border of the left, within the lunule, and the overlapping border of the left valve and the entering border of the right, within the escutcheon, be regarded as teeth, the number of both the anterior and posterior laterals is two in each valve; ligament

[1] The names under which I have described these forms respectively are *Dalliconcha*, *Stearnsia* and *Aguileria*. They are given in honor of Dr. W. H. Dall and Dr. R. E. C. Stearns of the U. S. Geological Survey, and of Señor José G. Aguilera, of the Mexican Geographical and Exploring Commission.

small, mainly internal; free margins apparently smooth; pallial line apparently simple.

This genus agrees with *Crassatella* in having both lunule and escutcheon clearly defined, in the general character of the hinge, exclusive of the lateral teeth, in the nearly internal position of the ligament, and, apparently, in having a simple pallial line. It differs from *Crassatella* in its small and compressed beaks, the laterally compressed form of the shell, in its greater number of cardinal teeth; and in the long and slender character of both the anterior and posterior lateral teeth.

It agrees with *Astarte* in having both lunule and escutcheon well defined; but it differs from that genus in having a greater number of cardinal teeth; in its well developed anterior and posterior lateral teeth; and in having its ligament mainly internal.

It agrees with *Circe* (as represented by *C. scripta*, Lin.) in its laterally compressed form, especially that of the umbonal region, and in the number of its cardinal teeth. It differs from *Circe* in having its ligament mainly internal; in the long and slender character of the anterior lateral teeth, and in the possession of posterior lateral teeth.

It agrees with *Eryphila* in having both lunule and escutcheon well defined, and, approximately, in the character of its posterior and anterior lateral teeth. It differs from that genus in having a greater number of cardinal teeth, and in having its ligament mainly internal.

It has somewhat the aspect of *Gouldia*, but it differs from that genus in having slender, well developed posterior, as well as anterior lateral teeth. It has also a greater number of cardinal teeth than *Gouldia* and its ligament is differently situated and partly external.

The only species of this genus which I have satisfactorily examined is the one which is described in the following paragraph. This I regard as the type of the genus, bnt it is likely that the *Astarte carinata* of d'Orbigny[1] is congeneric with it.

Stearnsia Robinsi (sp. nov.) Pl. II, figs, 7—9.

Shell much compressed, trihedral in marginal outline; lunule long and narrow, nearly straight from end to end, concave transversely; escutcheon similar in shape and character to the lunule, but longer; beaks small, appressed, angular; ligament slightly

[1] See Palcont. Francaise, Ter. Cret. iii, pl. 262, figs. 1. and 2.

exposed, and it appears to have been divided into an outer and inner portion by a calcareous septum; umbonal furrows distinct, producing an emargination at the posterior part of the convex basal border and a considerable prominence of the posterior extremity; hinge strong; the lateral teeth slender and extending the full length of the lunule and escutcheon respectively; surface marked by strong concentric furrows and ridges, which end abruptly at the margins of the lunule and escutcheon respectively; the surface of both lunule and escutcheon plain,

AVICULIDÆ.

Genus DALLICONCHA (gen. nov.).

Shell resembling *Gervillia* in general form, in the character of the test, in the muscular markings, and in the possession of a pit-bearing diverging hinge area upon each valve. The valves are more or less nearly equal in convexity; beaks terminal, divergent; the upper borders of the hinge areas converging from the widely separated beaks to the posterior end of the wing, where the areas come in contact with each other by their full width; posterior wing elongate, clearly defined from the body of the shell; anterior wing absent, the anterior extremity of each valve being inflexed so as to form, when both valves are together, a three-lobed depression in the front portion of the shell, one lobe of which ends at the extremity of each of the divergent beaks and the other below, at the contact of the antero-basal margins of the valves. At the bottom of the depression there is a distinct byssal aperture, to form which both valves are nearly or quite equally notched. The articulating portion of the hinge of each valve is marked by more or less distinct crenulations which cross it obliquely downward and backward, and which are sometimes visible upon the surface of the areas above the articulating border. At the anterior end of the hinge these crenulations are approximately perpendicular, and sometimes denticulate in character, and at the posterior end they sometimes assume the form of slender, nearly horizontal lateral teeth, above which are more nearly transverse crenulations.

Dalliconcha agrees with *Gervillia* in the characteristics already mentioned; but it differs from the typical forms of that genus mainly in the inflection of the anterior extremity of the valves, and the consequent terminal position of the beaks, and absence

of an anterior ear. It also differs in wanting the large, longitudinal teeth which characterize true *Gervillia*—as seen, for example, in *G. difficilis* d'Orbigny, and *G. anceps* Deshayes.[1] The byssal aperture is also more clearly defined than in *Gervillia.*

In these differing features it agrees approximately with *Perna;* but it differs conspicuously from *Perna* in its much more elongate form, in the distinct definition of the posterior wing, the smaller number of ligamental pits, and in the crenulation of the hinge. This genus is more nearly related to *Gervillia* than to any other genus of the Aviculidæ, the relation between the two genera being somewhat similar to that which exists between the living forms of *Avicula* and the Carboniferous genus *Monopteria* of Meek and Worthen.

The species which is described in the following paragraph is proposed as the type of *Dalliconcha,* but the *Gervillia ensiformis* of Conrad is an equally typical species. The *G. aviculoides* of Defrance (not Sowerby) and *G. solenoides* Defrance seem also to belong to this genus, as doubtless do several other forms which have been referred to *Gervillia.*

Dalliconcha invaginata (nov. sp.). Pl. II, figs. 4 and 5.

Shell long and slender; the dorsum gently concave from beak to posterior end, and transversely flattened by the abrupt inflection of the dorsal border of each valve; wing well developed; the anterior depression rather deep; beaks prominent; byssal aperture moderately large, oval; hinge-areas each bearing five or six ligamental pits, which are of unequal size; the spaces between the pits marked by irregular oblique crenulations.

Genus AGUILERIA (gen. nov.).

Shell resembling *Perna* in general form, in the character of the test, in its muscular markings, and in the possession of a pit-bearing, diverging hinge area upon each valve. The valves are more or less nearly equal in convexity; a more or less distinct furrow passes from the dorsal border of each valve, near the apex of the beak, to the anterior margin, defining a projecting, more or less inflated anterior portion of the shell, which is homologous with the anterior ear of *Margaritophora.* The beaks are not prominent, situated anteriorly, but not terminal; ligamental pits distinct, but not numerous. The articulating

[1] See Paleont. Francaise, Ter. Cret., iii, pl. 394, fig. 3; and pl. 396, fig. 7

portion of the hinge of both valves of the adult examples of the type species is marked by crenulations or denticles, which cross the hinge at nearly right angles in front, but at the posterior portion their course is obliquely downward and backward.

In the type species a small blunt tooth is observable at the anterior end of the hinge of the left valve; and there is a larger, more oblique one at the posterior end of the hinge. There are corresponding pits in the left valve to receive these teeth, and some specimens also show a slight elevation at the side of the anterior and posterior dental pits respectively, suggesting that they represent incipient teeth in that valve. Byssal aperture obscure or absent.

This genus agrees with *Perna* in the characters which have already been mentioned, but it differs from *Perna* in the retreating position of the beak, in the projecting instead of inflected anterior extremity of the shell beneath the beaks, in the crenulation of the articulating portion of the hinge, in the smaller number of ligamental pits, and in the absence of a well-defined byssal notch in either valve.

It agrees with *Margaritophora*, as shown, for example, by the living species *M. pica* Gould, from the southern Pacific Ocean, in the character of the test, in the muscular markings, in the possession of blunt teeth upon the anterior and posterior portions of the hinge, and in the retreating position of the beaks. It differs from *Margaritophora* in having well-developed ligamental pits in its hinge areas, a crenulate or denticulate, instead of a smooth hinge border, and in the absence of a compressed anterior ear, and of a distinct byssal notch.

Bakevellia has some characteristics similar to those of this genus, but its ligamental pits are fewer in number and occupy only the middle portion of the hinge, while its lateral teeth are two or three in number at each end of the hinge, and they are nearly parallel to the hinge border; the latter being smooth and not crenulate. Besides this there is some reason to doubt whether *Bakevellia* really belongs to the family Aviculidæ, as do *Perna* and its congeners; and to which family this new genus is referred.

The species which is described in the following paragraph is proposed as the type of *Aguileria*. Señor Aguilera has shown me some examples of a species which he obtained from the Cre-

taceous rocks of the State of Puebla, Mexico, which is probably congeneric with this Texan form. It is probable also that the *Gervillia Renauxiana* of Matheron, and other published forms, ought to be referred to the genus here proposed. A form from the Cretaceous of Brazil, described by me some years ago under the name of *Gervillia dissita*, but still unpublished, seems to belong to this genus. If those species should be assigned to this genus it may be that the crenulation of the hinge will be found to be an inconstant character; but the other characters which are herein described are regarded as a sufficient basis for its generic identity.

Aguileria Cumminsi (sp. nov.). Pl. II, figs. 1-3.

Shell inflated, obliquely subelliptical in marginal outline; test thick, hinge line moderately long; hinge areas broad, bearing three or four ligamental pits; hinge border including the surface of the cardinal teeth, distinctly crenulated in adult examples; posterior cardinal tooth moderately large; anterior one small and indistinct.

EXPLANATION OF PLATE II.

Aguileria cumminsi White.

FIG. 1. Left side view of an adult example.

FIG. 2. Dorsal view of the same.

FIG. 3. Interior view of a left valve, somewhat narrowed by lateral compression, showing the hinge and cardinal area.

Dalliconcha invaginata W.

FIG. 4. Right side view of a restored outline, reduced to three-fourths natural size.

FIG. 5. Front view of an adult example, restored as to its outline from a partially crushed condition.

Dalliconcha ensiformis Conrad, sp.

FIG. 6. A left valve, showing hinge and front features; introduced for comparison.

Stearnsia robbinsi W.

FIG. 7. Left side view of a medium-sized example.

FIG. 8. Dorsal view of the same.

FIG. 9. An imperfect example, showing the hinge of the left valve.

All the figures except 4 are of natural size.

FEBRUARY 1.

The President, Dr. JOSEPH LEIDY, in the chair.

Twenty-two persons present.

Papers under the following titles were presented for publication;

"On the Cretaceous Formations of Texas, and their reations to those of other portions of North America," by Charles A. White.

"On Zinc—Manganese Asbestos," by George A. Koenig, Ph. D.

Parasite of a Bat.—Dr. LEIDY remarked that it was a common opinion among country people that swallows and bats were infested with bed-bugs and often introduced them into houses. He had convinced himself that the *Cimex* infesting the cliff-swallow was a different species from the bed-bug.[1] He had repeatedly examined bats without finding *Cimex*. On one of two small bats, from Panama Bay, presented this evening by Dr. Wm. H. Jones, he found two singular insects, which appear to be the *Polyctenes fumarius*, described by Prof. Westwood from a bat of Jamaica. They are about half of the size given for the species, but otherwise appear to agree in all respects. It has four jointed antennæ, with the first pair of limbs short and the other pair long. The insect has distinct hemielytra.

On a Peculiar Form of Molybdenite.—Dr. GEO. A. KOENIG called attention to a specimen of Molybdenite from the Germantown quarries, presented by Mr. Thomas Meehan. The Molybdenite forms a perfect cylinder, 2 inches long by ½ inch diameter. It shows a lamellar structure, but the leaves are twisted and felted together. Owing to the remarkable shape the speaker had supposed the substance to be graphite and placed by some persons—quarrymen—in a ½ inch drill-hole, ramming it down tightly. Blowpipe tests, however, show the substance to be Molybdenite. In the open tube a peculiar odor was noticed not quite like that of Selenium but near it, and it was believed to be desirable that a quantitative analysis should be made.

FEBRUARY 8.

Mr THOMAS MEEHAN, Vice- President, in the chair.

Fourteen persons present.

A paper entitled "On Invertebrates from the Eocene of Mississippi and Alabama," by Otto Meyer, was presented for publication.

The following were ordered to be printed.—

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[1] Proc. 1877, 284.

ON THE CRETACEOUS FORMATIONS OF TEXAS AND THEIR RELATION TO THOSE OF OTHER PORTIONS OF NORTH AMERICA.

BY CHARLES A. WHITE.

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The true relations of the different Cretaceous formations which have long been known to exist within the State of Texas to each other, and to those which have been recognized in other portions of North America, have not hitherto been satisfactorily known. Several eminent geologists have written upon the subject, and considerable diversity of opinion has prevailed among them. The former impracticability of obtaining information by personal observation over any considerable portion of that great region; the destruction by the civil war of the work so well begun by Dr. Shumard, and the limited knowledge then possessed by any one of the general geology of North America, were doubtless the causes which prevented a satisfactory solution of this question. Now numerous railroads traverse the State, the hostile tribes which barred the progress of travelers have been quieted or removed, and a good outline of the geology of the continent is known.

With the opportunity of availing myself of these advantages I entered last year upon an investigation of the Texas Cretaceous, placing the field work in charge of my chief assistant, Mr. Robert T. Hill. In the latter part of the season I traversed the State in various directions in company with Mr. Hill, reviewing his work and making additional observations. The following section is the result of these labors, and I am so well convinced of the accuracy of its essential features that I do not hesitate to adopt it as the basis of my paleontological and museum work in relation to the Texas Cretaceous, although the order of superposition therein given is so different from what it has been generally supposed to be.

The remarks at the right hand side of the column, which represents the section, are by Mr Hill, who has with considerable care compared this section with those which have hitherto been published as representing the Texas Cretaceous.

General Section of the Cretaceous Strata of the Eastern half of Texas.

GULF SERIES.	7. NAVARRO BEDS.	7. Strata in Navarro County, given this name by B. F. Shumard and correlated with the Ripley Group in 1861; but not placed in his general section of 1860; correlated with Ripley Group at Terrell by R. H Loughridge; 10th Census Report, Vol. V. Included by Roemer, together with 4 and 5 of this section, in his "Kreidebildungen am Fusse des Hochlandes." Outcrops along a narrow area upon the western border of the Gulf States Tertiary.
	6. AUSTIN LIMESTONE.	6. Outcrops to the west of No. 7. occupying the so-called Black Prairie region. Of great thickness and uniformity of character Recognized by Owen as extending into Arkansas, and as equivalent with the rotten limestone of Mississippi, named "Austin Limestone" by B. F. Shumard in 1860, and placed in his section between Nos. 2 and 3 of this section, but its true relation not then recognized. Included by Roemer with No. 7. Sherman, Dallas, Waco, Austin and New Braunfels are approximately upon the western border of the outcrop.
	5. EAGLE FORD SHALES.	5. Yellow arenaceous, and blue argillaceous shales, narrow exposure west, and along the northern half of No 6. Is the lower part of Shumard's Austin limestone, and also the "Arenaceous Group" and "Fish Bed" of his Lower Cretaceous.
	4. TIMBER CREEK BEDS.	4. Coarse ferruginous sands and clays; fossiliferous. Has been alluded to by various writers as "Tertiary," "Miocene," "Quaternary," etc. Its outcrop is coextensive with the region know as the Lower Cross Timbers. It apparently rests unconformably upon No. 3.
COMANCHE SERIES.	3. WASHITA DIVISION.	3. Strata of this division at Fort Washita, I. T., partially described in 1854, and called "Senonien" by G. G. Shumard, wrongly placed by B. F. Shumard, in his section, immediately beneath No. 6 of this section. More comprehensively described by Jules Marcou in 1855, and referred to the Neoconian. Is not distinctly separable from No. 2, either by the character of the strata or fossil contents. Outcrop occupies a narrow belt extending southward from old Fort Washita via Denison. Denton, Fort Worth, Salado, Austin, and westward of San Antonio; was included together with No 2 by Roemer in his "Kreidebildungen des Hochlandes."
	2. FREDERICKSBURG DIVISION.	2. In 1848 this division was included by Roemer in his "Kreidebildungen des Hochlandes," as seen in buttes north of Fredericksburg. It is also the "Comanche Peak Group," the "Caprina Limestone" and "Caprotina Limestone" of B. F. Shumard in 1860. These authors placed all except the last named strata at the top of the whole Texas Cretaceous series. Outcrops along the borders of the paleozoic areas in Central Texas.
	1. DINOSAUR SANDS.	1. Coarse silicious sand,, popularly called "pack-sand." Occurs between the base of the fossiliferous Cretaceous and the carboniferous series. Contains vertebrate remains.

The fossils which have been collected from the strata of this Texas section, have not yet been fully studied with reference to the different formations which they represent. That work has, however, so far progressed as to give some important indications as to the equivalency of certain of these Texas formations with those which different geologists have investigated in the regions to the eastward, westward, and northward from that State; and also to show that a large part of the Texas Cretaceous section is not represented by any of the formations referred to. The following table will serve to formulate these indications, but as the recognition of equivalency is more satisfactory in some cases than in others, each case is considered separately in the following paragraphs:—

Mississippi Section.	Texas Section.	Western Section.	Upper Missouri River Section.
Ripley Group.	Navarro Beds,	Fox Hills Group.	Nos. 4 & 5, or Ft. Pierre and Fox Hills Groups.
Rotten Limestone.	Austin Limestone.	Colorado Group.	Nos. 2 & 3, or Ft. Benton and Niobrarra Groups.
Tombigbee Sand.	Eagle Ford Shales		
Eutaw Group.	Timber Creek Beds.	Dakota Group.	No. 1, or Dakota Group.
Wanting.	Washita Division.	Wanting.	Wanting.
Wanting.	Fredericksb'g Division.	Wanting.	Wanting.

Before making comparisons of the Texas section with the others of this table, it is necessary to make some explanations with reference to the relations of the latter to each other.

The Mississippi section indicated in the foregoing table is that which was published by Prof. E. W. Hilgard in his official report upon the geology of the State of Mississippi.[1] The western section is a modification, first proposed by King,[2] of the well-known Upper Missouri River section of Meek and Hayden, which is represented by the right-hand column. King, however, placed the equivalents of Nos. 3, 4 and 5 of the Upper Missouri section all together under the name of Fox Hill Group. This being an unnatural grouping of the strata upon paleontological grounds, I still further modified it by placing Nos. 2 and 3 together under King's name of Colorado Group; and Nos. 4 and 5 together under one of the original names of Fox Hills Group

[1] Geology and Agriculture of Mississippi, 1860, p. 3;
[2] U. S. Geol. Expl., 40th Parallel, vol. i, pp. 305, 306.
[3] Ann. Report U. S. Geol. Surv. Terr. for 1876, p. 22.

These two consolidated groups, together with the Dakota Group, the separate identity of which all geologists have recognized, constitute the western Cretaceous section of the foregoing table.

The New Mexican Section of Prof. Newberry seems to be practically identical with the western section of the foregoing table.[1] He seems to indicate, however, that there is in that region a blending of the Dakota Group with the next overlying formation. It may be noted also that at least one of the species which Mr. Meek describes in that report as coming from the middle division of the New Mexican Section[2] is now known to belong to a lower horizon than that of the base of his section, namely, to that of the Comanche division of the Texas section.

Southward from Dakota and Montana I have never been able to separate the equivalent of No. 4 from that of No. 5 of Meek and Hayden's section, either stratigraphically or paleontologically. It is for this reason that I have referred all strata that carry any of the fossils which they indicated as characterizing either of those divisions to the Fox Hills' Group alone. On the other hand, while Nos. 2 and 3 are so closely related to each other paleontologically that they are now generally regarded as constituting one natural group, an upper and a lower lithological division of the same are quite as clearly recognizable in southern Colorado and northern New Mexico as in the Upper Missouri River region.

It is a significant fact that while the separate identity of the Dakota group has been indicated by specific identity of plant remains, which are found over a large region, as well as by stratigraphical position, there is a marked difference in the character of the invertebrate fossils from different localities. I refer especially to those which Mr. Meek[3] and myself[4] have published as coming from strata of that group in Central Kansas, as compared with the few which have been found in southeastern Dakota. The Kansas forms are mainly or wholly of marine origin, but they are such as may have lived in littoral waters; while those of southeastern Dakota are of different species, and indicate a

[1] Newberry's Geol. Rept. Expl. Exped. from Santa Fe to Junction of Grand and Green Rivers, pp. 32, 121, 122.

[2] Ib., p. 126, pl. i, figs. 7 *a*, *b*.

[3] Ann. Report U. S. Geol. Sur. Terr. for 1870, pp. 297, 301–313; Vol. IX U. S. Geol. Sur. Terr., p. 24.

[4] Proc. U. S. National Museum, Vol. 2, pp. 295, 296, pl. 5.

less saline condition. It is also significant that, with the exception of some marine mollusca which Mr. Meek doubtfully referred to the Dakota group in New Mexico,[1] no other invertebrates than those which the Kansas and Dakota localities have furnished, have been reported as coming from that group. The facts which have been mentioned, others which will be referred to, and our present knowledge of the general geology of that western region, all seem to indicate that while the greater part of the Dakota group, as it is now known, is a non-marine deposit, we ought to expect to find it to merge into a marine deposit to the southward.

Now in making comparisons of the Texas Cretaceous rocks with those which have been observed in other parts of the continent, we find that the whole Comanche series represents older strata than are included in any of the other published sections of North American Cretaceous except perhaps that of California.[2] The strata of the Comanche series are known to extend northward from Texas into the Indian Territory, and some of its characteristic fossils have been found in southeastern Kansas. Fossils belonging to this series have also been found at various points in western Texas and the adjacent southeastern part of New Mexico. They have also been found at various points in Mexico, one locality being upon the western side of the Sierra Madre, in the Mexican State of Sonora.[3]

Judging from all the information which I have been able to obtain, I infer that none of the strata of the Comanche series extend beyond the eastern boundaries of Texas, nor further northward than southern Kansas. It seems probable also, that while this series is well developed, both faunally and stratigraphically, in Texas, it has, or originally had, its greatest development within the region which is now the Republic of Mexico.

Again, judging from present information, there seems to be a complete faunal break at the top of the Comanche series. That is, I am not yet aware that a single fossil species of that series passes up into any of the upper members of the Texas Cretaceous Section. The Comanche series is therefore not only greatly restricted in its geographical extension to the eastward and

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[1] Newberry's Geol. Report before cited, p. 121.

[2] White; Bull U. S. Geol. Surv., No, Vol· 15, p. III, 1885.

[3] Gabb; Paleontology of California, Vol. II, p. 257.

northward, but there seems also to be a clear line of demarkation between that series and the upper one, within the State of Texas. No unconformity of the strata of the upper series upon those of the latter has yet been satisfactorily observed, but it can hardly be doubted that there is at least a brief chronological break between the two series. This latter question, however, I am not now prepared to discuss.

From the foregoing remarks it will be seen that it is the formations of the upper series alone which can now be discussed with reference to equivalency with the formations represented by the other sections of the foregoing table. Beginning with the lowest member of the upper, or Gulf series, namely, the Timber Creek beds, I regard those strata as, at least in part, equivalent with the Dakota group of the Western and upper Missouri sections, and perhaps equivalent with the Eutaw group of the Mississippi section. Of the latter supposed equivalency I have no paleontological evidence; and the suggestion is made mainly in consequence of the stratigraphical position of the Eutaw group.

That the Timber Creek beds are equivalent with the Dakota group is indicated not only by the position of each with reference to overlying formations, but I have recognized some of the species which were first found in the Dakota strata of central Kansas, in the Timber Creek beds of Denton County, Texas.

The Eagle Ford shales are recognized as equivalent with the bluish shales, or lower portion of the Colorado group as it is known in Colorado and the adjoining territories. That is, I have recognized certain of the species of the Eagle Ford shales as identical with some which occur in the Colorado group to the northwestward of Texas. The lithological character of the shales of both regions is also similar.

As to the equivalency of the Eagle Ford shales with the Tombigbee sand of the Mississippi section, the only reason I now have for offering that suggestion is its stratigraphical position.

That the Austin limestone is equivalent, both stratigraphically and paleontologically, with the rotten limestone of the Mississippi section, as has been shown by other authors, there seems to be no reason to doubt. I also regard those Texan strata as equivalent with the upper division of the Colorado group. The Texan strata are not only quite similar in lithological character

to those of that division as it is known in southern Colorado and New Mexico, but I have recognized several species of fossils as common to the Austin limestone and those more northern strata.

The paleontological evidence that the Navarro beds are equivalent with the Ripley group of the Mississippi section, as presented by Shumard,[1] seems to be beyond question. It is also known that several molluscan species which characterize the equivalents of the Navarro beds in the Cretaceous of the Gulf and Atlantic coast regions, are not uncommon in the Fox Hills group of the Western section.

The Fox Hills groups of the Western section is clearly recognizable as such in the valley of the Rio Grande, in western Texas, where it is found to contain a number of the characteristic species of the group. The evidence is conclusive, also, that the Fox Hills strata there, are, or originally were, directly continuous with those of that epoch which are found to the northward.[2] Of the present, or former, direct stratigraphical continuity of the western Fox Hills strata with their presumed equivalents in Eastern Texas, and in the Gulf and Atlantic coast regions, present evidence is not so clear.

Although the identity of certain species, found in those eastern and western strata respectively, is beyond reasonable question, there is a decided difference, both paleontological and lithological, between them. Still, there seems to be good reason for regarding them as having been synchronously deposited. Their differences were perhaps largely due to the presence of a land area between an eastern and a western marine area during the Fox Hills-Ripley epoch, to the southward of which the two marine areas coalesced. This view seems to find corroboration in the fact that most of the species which are common to both the eastern and western strata, are open sea forms, and consequently had a wide geographical range. Those species which differ most in the two regions respectively, are apparently such as had a more restricted range.

We now come to consider the relation of the Fox Hills strata and the Navarro Beds respectively, to overlying formations. It appears to be unquestionable that the Lignite Tertiary Beds of eastern Texas rest directly upon the Navarro Beds, just as the

[1] Proc. Bost. Soc. Nat. Hist., viii, p. 189.

[2] This volume, pp. 18–20.

equivalent Tertiary strata rest upon the Ripley Group in Mississippi; but in Texas the actual contact seems not yet to have been seen by a competent observer. The faunal difference also, between the Navarro and the Lignite Beds, plainly indicate a change in physical conditions, and also a chronological break of some extent. The break, however, may have been only a brief one.

On the other hand, the strata of the Fox Hills Group in the region of the Rio Grande are directly overlaid by those of the Laramie Group, the two formations so blending together that no sharply defined plane of demarkation between them can be recognized. Thus we find the stratigraphical series in that western region to be an unbroken one up to the top of the Laramie Group; while the eastern series is broken at the top of the Navarro Beds. We are therefore still in doubt as to the true stratigraphical relation of the Laramie Group with the Eocene Tertiary of the Gulf region. If that relation is ever discovered, it now seems certain that we shall find it in the southwestern part of Texas, or the adjacent part of Mexico.

The Dakota Group of the western and upper Missouri sections rests directly upon Jurassic strata, which in turn rest upon a series known as the "Red Beds," and usually regarded as of Triassic age. Those Red Beds are there found to rest upon the Carboniferous, or upon older paleozoic rocks. No equivalent of the Jurassic strata referred to have been recognized in connection with the Texas Cretaceous section as given in this article; and they seem to have entirely thinned out before reaching the region of Central Texas. In that region, the strata next underlying the Comanche series are clearly either those of the Carboniferous, or of the Red Beds. The latter are not known to exist to the eastward of the Carboniferous area of Northern Central Texas, but they reach considerable thickness upon the western side of that area, where they are usually known as the Gypsum formation.

It appears from the investigations upon which this article is based that certain of the members of the Texas Cretaceous section have not heretofore been recognized, and that the true order of superposition of the formations has been misunderstood, the theoretical section of Marcou[1] being more nearly correct than any heretofore published. It also appears that while the lower

[1]Proc Boston Soc. Nat. History, Vol. VIII, p. 93.

series of that section is not represented in any of the other published sections in North America, the upper series may be satisfactorily correlated with the western and upper Missouri sections; and in part, at least, with the Cretaceous formations of the Gulf, and Atlantic coast regions.

In making these investigations the really valuable work of Dr. B. F. Shumard has been adopted so far as practicable, and a large proportion of the fossil species which he published, but did not figure, have been recognized. The admirable work of Prof. Roemer also is found to be as useful to-day as it was when it was first published, forty years ago.

ON ZINC—MANGANESE, ASBESTOS.

BY GEORGE A KOENIG, PH. D.

During a visit to the Franklin Zinc Mines in 1879, I obtained from Mr. George, then Superintendent of the Trotter mine a considerable quantity of Sussexite. Among this there was some material which did not quite look like the rest, and was subjected to an investigation. This material I will designate A. After finding it of interest, I obtained from my friend and colleague, Dr. F. A. Genth, a bluish asbestiform mineral from the same locality; this will be designated as material B.

Both appear as stiff, rather columnar fibres, and effervesce with acid. But after treatment with dilute HCL, a fine silky mass ot fibres remain, and these were analyzed. The needles appeared under the microscope slightly yellowish or colorless, whilst the substance in bulk appeared bluish, like crocidolite or brown black.

These needles fuse readily before the blow-pipe with intumescence to a black globule, and behave thus like Sussexite. But no color is given to the flame, so characteristically green in Sussexite.

After extracting with acid, whereby A gave 73 asbestos, 27 calcite, and material B gave 85 asbestos, 15 calcite, the residue was thoroughly dried at 130°C., and then analyzed as follows:—

	A.	B.
SiO^2	= 55·84	53·50
Al^2O^3	= ——	1·36
Fe^2O^3	= ——	8·12
MgO	= 19·58	14·58
CaO	= 10·00	6·62
MnO	= 4·79	1·70
ZnO	= 4·59	7·10
FeO	= 2·40	4·68
H^2O	= 3·20	3·34
	100·40	101·00

The molecular ratio is formed for—

SiO^2 : (Mg, Ca, Fe, Zn, Mn H^2) O

A. 1·8613 1·9716

1·00 1·06

(Mg, Ca, Fe, Zn, Mn H^2) SiO^3

SiO^2 : $(Al^2Fe)^2$: Mg, Ca, Zn Fe H^2) O

B. 1·7833 : 0·1279 : 1·6911

Or, if we add the sesquioxides to the protoxides—

$$\frac{1·7833}{1·8190} = 1·00 : 1·016$$

We have here then two Bisilicates, remarkable for the polybasic composition, which are either pyroxene or amphibole asbestiform. I am inclined to classify them as amphibolic. It is probable that these silicates are in a number of collections under the name of Sussexite, with which notably the material A shows much resemblance.

FEBRUARY 15.

Mr. GEO. W. TRYON JR. in the chair.

Twenty-four persons present.

Grampus Rissoanus on the American Coast.—Prof. HEILPRIN called attention to the recent stranding on the New Jersey coast, at Atlantic City, of Risso's whale, *Grampus Rissoanus*, a form readily distinguished from other allied cetaceans by the peculiar slaty lines which are irregularly distributed over the body. The speaker thought that this was the first instance of this singular Mediterranean species having been recorded from the trans-Atlantic waters, and emphasized the difficulty of drawing lines of delimitation to the oceanic faunas. The specimen in question was dark-slaty in color on the sides, verging to black on the back and measured about eleven feet in length.

FEBRUARY 22.

Mr. CHARLES MORRIS in the chair.

Nineteen persons present.

Origin of the Excretory System in the Earth-worm.—Professor EDMUND B. WILSON, of Bryn Mawr, Pa., laid before the Academy an account of his observations on the development of *Lumbricus olidus*, calling especial attention to the remarkable similarity that exists between the development of the nephridia and the origin of the excretory system in the vertebrates. The gastrula is formed by a process of invagination. Upon the establishment of the germ-bands, they are found to be essentially similar to those of *Clepsine*, ending behind in eight large cells, by the continued division of which the bands increase in length as the embryo grows. Two of these large cells are mesoblasts (giving rise to the dissepiments, muscles and vessels) two are neuroblasts (giving rise to the ventral nerve-cord), two are nephroblasts (giving rise to the excretory organs)and two give rise to cells whose fate could not be determined. From each of these cells a row of cells extends forwards on the ventral side of the body between the ectoblast and entoblast. The rows are at first one cell wide, but are converted in front into solid cords, several cells in thickness. The principal interest of the development lies in the origin and fate of the rows

produced by the nephroblasts; these rows are designated as the nephridial rows. In each somite a solid outgrowth from each nephridial row takes place into the coelom and is ultimately converted into the nephridium of the corresponding side. Thus the nephridia arise as metameric outgrowths from a solid cord of cells that lies in the somatopleure; and their mode of development is therefore essentially similar to that of the segmental tubes of the vertebrate head-kidney or pro-nephros.

An examination of the origin of the nephroblast demonstrates the fact that it is originally an ectoblastic cell, which extends to the surface of the body and is only in rather late stages to be distinguished from other ectoblastic cells by its greater size and by the fact that it sinks below the surface. It always remains, however, embedded in the ectoblast, and unquestionably is derived from that layer. The nephridial rows and the nephridia to which they give rise are therefore ectoblastic structures.

This conclusion is believed by Prof. Wilson to establish two interesting homologies, namely: between the nephridial row of *Lumbricus* and the Wolffian or segmental duct of the vertebrates, and between the series of nephridia of annelides and the vertebrate head-kidney or pro-nephros. It has very recently been shown that in *Raja*, *Rana*, *Lacerta*, guinea-pig and the rabbit, the segmental duct is derived directly from the ectoblast by a mode of development essentially like that of the nephridial row of *Lumbricus*. Hatschek, Eduard Meyer and Lang have already called attention to the close resemblance between the Wolffian duct of vertebrates and the longitudinal canal that unites the nephridia in the larval *Polygordius* and in certain adult annelides. Prof. Wilson's observations, taken in connection with those of Meyer supply the embryological proof that the two structures are actually homologous, and that the excretory systems of annelides and of vertebrates are constructed upon fundamentally the same type and originate by similar modes of development. Attention was called to the direct bearing of this result on current theories relating to the origin of the Vertebrata.

MARCH 1.

The President, Dr Jos. LEIDY, in the chair.

Twenty-six persons present.

A paper entitled "The Summit Plates in Blastoids, Crinoids and Cystids and their morphological Relations," By Charles Wachsmuth and Frank Springer, was presented for publication.

The following was ordered to be printed:—

ON INVERTEBRATES FROM THE EOCENE OF MISSISSIPPI AND ALABAMA.

BY OTTO MEYER. Ph. D.

In the illustrations to the following paper, the figures of some insufficiently known species of the Southern Old-Tertiary are included. Notes on these are given. The species referred to are mostly small ones. All the mentioned material has been collected by me and is in my collection.

Odostomia Boettgeri n. sp. Pl. III fig. 4.

Subulate, polished. Nucleus sinistral, vertical, partly hidden, Adult whorls eight, with an impressed line below the suture. Suture distinct. Mouth subelliptical. Inner lip with a strong, nearly horizontal fold. At some distance from the outer lip there are within six raised revolving lines.

Vicksburg, Miss. "*Lower Vicksburgian.*"

Turbonilla major n. sp. Pl. III fig. 3.

Nucleus sinistral, its axis horizontal, its volutions separate. Adult whorls many, subconvex, covered with strong transverse ribs and densely spirally striated. The spirals do not extend over the ribs. Mouth subquadrangular. Inner lips with a strong oblique fold. Base spirally striated. *Jackson, Miss. Rare.*

The more common *Turbonilla* in Jackson is a form which I should rather put to *Turbonilla neglecta* Mr. than to the above species. Compared with *T. major* it is much smaller and more slender and the spiral striae are scarcely distinct, otherwise it is very similar.

DENTITEREBRA n. gen.

Turreted; transversely ribbed. Aperture narrow, terminating in a short anterior canal. Inner lip callous, very slightly striate. Outer lip crenulated internally, sinous posteriorly. Base striated.

On account of its mouth this genus is probably to be placed among the Columbellidae, in which family it is conspicuous by its turreted spire and transverse ribs. It is perhaps to be considered a subgenus of *Columbella.* If this is not the right position, it may belong to the Pleurotomidae.

Dentiterebra prima n. sp. Pl. III fig. 2.

The pointed nucleus consists of four volutions. Five adult whorls are covered by strong transverse ribs, eighteen on the body whorl; the surface else being smooth. Base with strong revolving lines, which are perceptible on the callus of the inner lip. The inner lip is else without striae or granulations. Crenulations of the outer lip six. Suture distinct, impressed. *Claiborne, Ala.*

I found only the figured specimen. It has the appearance of a young *Terebra.*

Pleurotoma Aldrichi n. sp. Pl. III fig. 7, 7a, 7b.

The nucleus consists of one and a half smooth inflated embryonic whorls. Adult whorls six; they are convex, raised below the suture, covered by transverse ribs and elevated spiral lines. Of the spiral lines those on the middle of the whorl are the strongest. The sinus is above the middle of the whorl. Aperture less than one third of the shell, with rather straight canal. The young shell shows a simple outer lip and a smooth, but not callous inner lip. The older the shell the more deposit on the inner lip it has. Old specimens apparently have strong folds within the outer lip.

Jackson, Miss.

I found eight specimens. The specimens, 7 b, has longitudinal folds within the outer lips, the uppermost of which is the strongest; besides it is somewhat stouter than the others. I consider it, however, as an old specimen of the same species, for the surface, though partially skinned, shows the same ornamentation, the characteristic nucleus is the same, and one of the other specimens shows an indication of the upper fold within the outer lip.

Tornatella volutata n. sp. Pl. III fig. 11.

Oval-elongate. The nucleus consists of one and a half smooth volutions, the first volution standing almost vertical and being partly hidden. Five adult whorls are slightly convex and covered with impressed revolving lines. These lines are slightly punctuate; number about six on each whorl, the body whorl excepted, where they are numerous and towards the base increase in distinctness and become closer. Mouth rather narrow. Outer lip sharp. Inner lip with a strong fold below the middle, and slightly covered by callus. Suture impressed.

Vicksburg, Miss. "*Higher Vicksburgian.*"

I found only the figured specimen. The species is considerably

cylindrical and approaches the subgenus *Actaeonidea* Gabb, from the Tertiary of the West Indies. It lacks, however, the anterior truncation of the collumella of *Actaeonidea.*

Unicardium? eocenense n. sp. Pl. III fig. 14, 14 a.

Small, tumid, solid. Margin subquadrangular, rounded anteriorly, truncate posteriorly. Beak turned anteriorly, before it a small cordate lunule. Lunular edge in front of the beak somewhat expanded. Below the beak one tubercular cardinal tooth (left valve), lateral teeth nearly obsolete. Anterior muscular impression elongated elliptical, posterior impression cordate-elliptical. Pallial impression not entire. Inside rough. Margin entire. Surface with indistinct concentric impressed lines, crossed by more distinct radiating lines. This ornamentation is wanting on the umboneal part and more distinct near the margin. The radiating lines are slightly more distinct on the posterior slope. *Red Bluff, Miss.*

The only found specimen, a left valve, shows three sinuations of the pallial line behind.—I have little doubt that this species belongs either to *Unicardium* d'Orbigny, or *Fimbriella* Stoliczka, or is to be placed in their neighbourhood. These two genera, however, are not known from the Tertiary formation, and if the Red Bluff form should prove to be a different and new genus I propose the name of *Cordiula* for it.

MIKROLA n. gen.

Minute, subtrigonal, inaequilateral. Anterior side rounded, posterior side attenuated. Ligament in a trigonal pit below the beak. In the right valve this pit is lodged between two compressed cardinal teeth. Left valve without distinctly developed teeth. Muscular impressions oval? Pallial line sinuated behind. Surface concentrically ribbed. Margin entire.

At first sight the genus has much resemblance to *Spheniopsis,* Sandberger, especially the left valve. But the dentition of the right valve is entirely different, and the genus may even not belong to the *Myidae.* I cannot discover any gaping of the valves.

Mikrola mississippiensis n. sp. Pl. III fig. 16, 16a, 16b.

Beaks almost obsolete. The concentric ribs of the surface end at the posterior terminal slope. Umbonial part smooth.

Red Bluff, Miss.

I found three double-valves of this species, which varies very much in the size and number of the concentric ribs. While one

of the specimens shows only three large and distant concentric ribs, another one is covered by about nine ribs.

Turritella carinata H. C. Lea. Pl. III fig. 1, 1a.

Turritella carinata H. C. Lea; Am. Journ. Science vol. XL, Jan. 1841. p 96, pl. 1 fig. 10.

Fig. 1 represents the largest specimen which I have from Claiborne and fig. 1a is a specimen which shows two of the round embryonic whorls. The name of this species is not preoccupied by *Turritella carinata* I. Lea, because this latter species is apparently identical with a form previously described.

Eulima lugubris Lea. sp. Pl. III fig. 8.

Pasithea lugubris Lea; I. Lea. Contrib. to Geology 1833, p. 101, pl. 4, fig. 81.

Eulima aciculata, Lea. sp. Pl. III. fig. 5.

Pasithea aciculata Lea; I. Lea. Contrib. to Geology, 1833, p. 102, pl. 4, fig. 82.

The specimen which I figure is from Jackson, Miss. It is apparently identical with Lea's Claiborne species.

Pasithea guttula Lea. Pl. III fig. 6.

Pasithea guttula Lea; I. Lea. Contrib. to Geology 1833, p. 104, pl. 4, fig. 86.

Cylichna Dekayi, Lea. sp. (var?) Pl. III fig. 10.

Bulla Dekayi Lea; I. Lea. Contrib. to Geology, 1833, p, 200, pl. 6, fig. 215.

The specimen which I figure, is from Jackson Miss. It is perhaps to be considered a variety of the Claiborne species.

Tornatina crassiplica Conr. sp. Pl. III fig. 9.

Bulla crassiplica Conr. Journ. Ac. Philad. I, 2nd Ser., Pl. 113, pl. 11, fig. 5.

Ringicula mississippiensis Conr. Pl. III fig. 12.

Ringicula mississippiensis Conr. Journ. Ac. Philad. I, 2nd Ser. p. 117; Pl. 18, fig. 36.

Dentalium subcompressum Mr. Pl. III fig. 13, 13a.

D. subcompressum Mr.; Am. Journ. Sci. 1885, XXIX p. 462. *D. subcompressum* Mr,; Bull. 1. Geol. Surv. Ala. 1886, p. 64, Pl. 3, fig. 3, 3a.

Fig. 13 represents a specimen with complete posterior end, showing also in this respect the great similarity of this species to *Dentalium compressum* Mr. from the German Oligocene.

Tellina eburneopsis? Conr. Pl. III fig. 15a, 15b.

?*Tellina eburneopsis* Conr. Am. Journ. Conch. 1865, p. 138, Pl. 10, fig. 17.

Conrad describes this species from the so-called locality "Entr prise, Miss." The specimen, which I figure, is from Jackson, M' Fig. 15b gives the profile of the posterior side, showing emargination at the posterior fold.

NOTES.

The following mistake is to be corrected. I described a specimen from Claiborne as "*Crucibulum antiquum*" (Bull. 1, Geol. Surv. Ala. 1886, p. 68 pl. 1 fig. 11). Having recently carefully cleaned the outside of this specimen it proved to be a *Balanus* with preserved operculum.

In an article "Beitrag zur kenntniss des Alttertiaers von Mississippi und Alabama"* I have given (p. 16, 17) a list of Foraminifera of the eocene of Mississippi and Alabama, which I collected and which were determined by Mr. A. Woodward. The following species, also collected by me and determined by Mr. Woodward, have to be added to this list.

Clavulina cylindrica Hantken; Matthews Landing, Ala.; Claiborne, Ala.; Jackson, Miss.; Wautubbee, Miss.

Cristellaria calcar Linné sp.; Matthews Landing, Ala.; Jackson, Miss.

Cristellaria cultrata Montfort sp,; Vicksburg, Miss. "Lower Vicksburgian."

Textularia agglutinans d'Orb.; Jackson, Miss.

Polymorphina oblonga d'Orb.; Jackson, Miss.

Polymorphina problema d'Orb.; Jackson, Miss.

Miliolina agglutinans d'Orb.; sp; Claiborne, Ala.

Truncatulina lobatula Walker and Jacob sp.; Jackson, Miss.

Truncatulina dutemplei d'Orb.; Jackson, Miss.

Pulvinulina canariensis? d'Orb; Jackson, Miss.

Nonionina depressula Walker and Jacob sp.; Wautubbee, Miss.

Explanation of Plate III.

Fig. 1. *Turritella carinata* H. C. Lea, nat. size; Claiborne, Ala.

Fig. 1a. " " " " showing two embryonic whorls; Claiborne, Ala.

Fig. 2. *Dentiterebra prima* n. gen. et n. sp; Claiborne, Ala.

Fig. 3. *Turbonilla major* n. sp.; Jackson, Miss.

Fig. 4. *Odostomia Boettgeri* n. sp.; Vicksburg, Miss.

Fig. 5. *Eulima aciculata* Lea. sp.; Jackson, Miss.

Fig. 6. *Pasithea guttula* Lea; Claiborne, Ala.

Fig. 7. 7, 7a, 7b. *Pleurotoma Aldrichi* n. sp.; Jackson, Miss.

Fig. 8. *Eulima lugubris* Lea; Claiborne, Ala.

Fig. 9. *Tornatina crassiplica* Conr. sp.; Vicksburg, Miss.

*Jahresber. d. Senckenbergischen Naturforschenden Gesellschaft, Frankfurt a. M. 1886. 2 plates.

Fig. 10. *Cylichna Dekayi* Lea. sp. (var?) Jackson, Miss.
Fig. 11. *Tornatella volutata* n. sp.; Vicksburg, Miss.
Fig. 12. *Ringicula mississippiensis* Conr.; Vicksburg, Miss. "Lower Vicksburgian."
Fig. 13. *Dentalium subcompressum* Mr.; Vicksburg, Miss.
Fig. 13a. The same specimen, view of posterior end.
Fig. 14, 14a. *Unicardium? eocenense* n. sp.; Red Bluff, Miss.
Fig. 15a, 15b. *Tellina eburneopsis?* Conr.; Jackson, Miss.
Fig. 16, 16a, 16a′. *Mikrola mississippiensis* n. gen. et. n. sp.; Red Bluff, Miss.

MARCH 8.

Mr. CHARLES MORRIS in the chair.

Fifteen persons present.

The deaths of Jos. Wilson M. D. and Bernard Persh, members, were announced.

MARCH 15.

Mr. JOHN H. REDFIELD in the chair.

Seventeen persons present.

Papers under the following titles were presented for publication:—

"A List of the Carices of Pennsylvania." By Thomas C. Porter.

"A Prodrome of a Memoir on Animal Locomotion." By Harrison Allen M. D.

On the First and Second Sets of Hair Germs Developed in the Skin of Fœtal Cats.—Prof. Ryder remarked that in a fœtal Kitten, three and one-half inches in length, which he had examined, the germs of certain hair follicles in the skin were more prominent than the great majority of other hair germs. These larger hair germs were especially obvious on the back and on the top of the head, where they formed very slight superficial elevations of the epidermis. Along the middle region of the back and head, these more prominent hair germ formed linear series or rows, which seemed to correspond somewha in position to the arrangement of the stripes of color on the back o the adults, as seen in the Ocelot and the black and grey-stripe variety of the domestic cat or grimalkin. On the sides and on t limbs the linear arrangement of these larger hair germs disapper entirely, and they were distributed in an irregular manner, p

uniformly amongst the smaller or less developed hair germs, which were everywhere far more numerous, being very probably the germs of the woolly coat or under-pelt.

It is possible that these larger hair germs represent the rudiments of hairs, which are more particularly sensory in function, and which, like the vibrissæ about the snout, and the groups of tactile hairs above the eyes, and the two groups on the cheeks of many mammals are more richly supplied with sensory nerves than others. The distribution of such tactile hairs in the Mammalia, was also considered by the speaker, who referred to the studies of Eschricht, Stannius and his own, on the distribution of such tactile hairs on the snouts of the fœtuses of various genera of Cetaceans, in which group it had been ascertained that they furnished very good characters diagnostic of species. It was also suggested in support of the view that larger hair germs on the body and head of the fœtal cat, were sensory in function, since they seemed to be arranged in conformity with the color areas on the back, which, as had been pointed out by Prof. Harrison Allen, were the recipients of special branches of the superior twigs of the intercostal rami of the spinal nerves in certain animals, (*Tamias.*) Hairs with a special function have also been found in other regions in the skin of mammals; as for example, certain hairs described by Schöbl on the interdigital wing membranes of bats.

Upon reflection, however, the preceding view of the facts bearing upon the development of two kinds of hair germs in the skin of the fœtal cat, were not wholly satisfactory. It was therefore deemed best to subject the skin of the fœtus in question to still more searching scrutiny. A portion of the skin from the top of the cranium of the fœtus was, therefore, carefully pealed off, stained in borax carmine and cut into sections and mounted as a series. This series of sections revealed several very interesting points, which it was impossible to make out from a more superficial examination.

It was found that the epidermis at this stage was only five or six layers of cells deep, and that there were two very sharply defined types of hair germs growing downwards from it into the corium. The larger and more advanced of these hair germs or follicles were very much thicker and larger than the others, and had penetrated more deeply into the underlying corium, than the less developed ones. At the point where the larger germs joined the epidermis, the latter was thickened so as to form the elevations marking the posi-

tions of the larger hair germs, when viewed from the surface. Further study also showed that the rudiment of a hair was well advanced in the larger follicles, while in the smaller ones only the first traces of the hair bulb had been developed, without as yet having given rise to the beginning of a cornified hair shaft. In both kinds of follicles the rudiments of sebaceous glands had been developed from the sides of their necks, though a lumen or cavity had hardly as yet been developed within them. The rete mucosum consisted of of scarcely more than a single layer of rounded cells; of this layer the younger developing follicles are principally composed.

These observations show that there are two distinct types of hair germs developed in the skin of the fœtal cat, one of which is much more advanced in development, and far less numerous, at the same period, than the other. It has also been shown that the larger germs have a certain orderly linear arrangement in some regions, as, for instance, along the dorsal region. The questions which now present themselves in addition to the interpretation already suggested, relate to the nature of these different kinds of hair germs. It seemed to him not improbable, as surmised by Professor Leidy, that the larger germs may be those of the contour hairs, while the smaller ones represent the germs of the finer hairs of the under pelt or woolly coat. Yet this view does not dispose of the question raised by the fact of the orderly arrangement of the larger germs along the back; nor are they numerous enough to be the germs of the contour hairs. It may be that this orderly arrangement relates to an ancestral condition, in which the hairs were fewer and while the ancestral mammalian type was still nearly cold-blooded. This view is supported by the fact that the temperature of the blood of the most reptilian of the mammalia, viz., the Ornithodelphia, is considerably below that of the Didelphia and Monodelphia, and that in at least one of these forms, *Echidna*, the spines, which represent hairs, are arranged in rows. In the other genus, *Ornithorhynchus*, the contour hairs are flat, the under-pelt of wool hairs being very densely set, while the contour hairs are not. Whether the quills or spines of *Echidna* are to be regarded as having descended by development from contour hairs i not known, but it is to be admitted that hairs of that type are mos likely to have been developed into quills or spines, since they gener ally project above the level of the woolly coat and have a much heavie shaft, which is always nearly straight and not crimped. Such origin may, with much show of probability, be ascribed to the qu of the porcupine.

In a number of mammalian orders, there is a marked tendency toward a dorsal, longitudinal striation, or linear alternation of bands or dots of color, and in a number of cases, this striation is well marked only in the young. This seems to be more than a mere coincidence and probably indicates that in the primitive or ancestral Mammalia, such a pattern was widely prevalent, if not universal. On the sides, on the other hand, there is a tendency toward alternating vertical colors with transverse bars on the limbs. This is a well-marked feature in the tiger, zebra and gnu. Later on it appears that these bars have broken up into dots, giving rise to the dappled or the spotted appearance of such forms as the leopard, giraffe and horse. These features have a very important phylogenetic significance, and point to an ancestral form, in which the color areas were disposed in bands. Looking about, amongst the lower groups, it is in Reptilia alone that we frequently find striping both longitudinal and transverse, and in that it is now admitted by some eminent authorities that the Mammalia are descended from the Reptilia (*Theromorpha*), some explanation is afforded of the prevalent type of color marking in the young of many feral Mammalian forms which are not striped when mature.

The dorsal longitudinal rows of hair germs in the skin of the fœtal cat also afford confirmatory evidence. Their coincidence with the bands of color and precocious development, indicates that they are remnants of a more primitive hairy coat. Their linear arrangement makes it possible to compare them with the linear and longitudinal arrangement of the feathers in birds and of scales in reptiles. In that hairs of mammals, feathers of birds and the corneous scutes of reptiles, are closely related structures and developed from homologous layers of the epidermis in these different classes, it is highly interesting to discover that the set of hair germs, which are the first to develop on the back of the fœtal cat, also show the primordial, linear arrangement of scales and feathers as observed on the backs of reptiles and birds.

A PRODROME OF A MEMOIR ON ANIMAL LOCOMOTION.

BY HARRISON ALLEN, M. D.,

Emeritus Professor of Physiology in the University of Pennsylvania.

The writer has undertaken at the request of the representatives of the University of Pennsylvania a series of studies on animal locomotion. The subject has been approached from the point of view presented by instantaneous photography, and has been especially based on the results obtained by Mr. Eadweard Muybridge. The writer desires in this connection to return his acknowledgments to Mr. Muybridge for opportunities in examining early impressions of the plates, which he is engaged in publishing under the auspices of the University, and also to state that he is indebted to Prof. Thomas Eakins for facilities afforded in studying the results of an experiment in the use of a modified form of Marey's wheel, devised by him in photographing the action of the horse in motion.

This short paper embraces the points which have been thought to have sufficient interest to appear in advance of the final memoir, and will include observations on the movements of the quadrupeds only.

Many of the statements could have been deduced from data already accessible to the writer. But since he wrote the paper immediately after the inspection of the photographs his conclusions may be said to be based upon them. At the same time he has not hesitated to include materials not embraced by the photographs. Whenever practicable the study of a given series was carried on at the same time that the animal itself lay dissected before him. For example, when studying the photographs of the elephant he had the good fortune, through the courtesy of Prof. Huidekoper, to dissect the limbs of an elephant. He has also dissected[1] the horse, the ox, the raccoon, the sloth, the skunk, the Virginian deer and the domestic cat.

THE USE OF TERMS.

It is necessary to propose the use of a few terms which will clearly express in a word a meaning which otherwise would require the employment of a cumbersome phrase. The words flexion, extension

[1] In this connection the writer wishes to give especial acknowledgments to his friends Prof. Horace Jayne and Mr. Edwin A. Kelly.

abduction, adduction, pronation and supination imperfectly express many animal movements. Thus no adequate word exists for the movement of the hand upward and downward when the forearm is held in semipronation. Such a motion is of importance in describing the wing of the bird and the bat. The term *Planation* is here thought to be convenient since it expresses the fact that the movement of the hand is in the plane of the flexor surface of the forearm. Planation includes both pronation and supination. *Contraplanation* as easily indicates a movement at an angle to the plane of the flexor surface of the forearm. It embraces flexion and extension and is not especially demanded, except that a term which includes both flexion extension as well as abduction, as used in the sense of abduction of the thumb, may be acceptable.

In like manner it has been found useful to employ terms for the different orders of the foot-falls.

Synchiry indicates that the right and left foot of a single pair act together. Thus in the gallop the horse moves all the feet synchirally. The movement of the lower limbs in man is also synchiral. The feet may act alternately or together.

Asynchiry would naturally embrace the movements in which the feet act in combinations of hind and forefeet. But since these movements are varied and important, it has been thought desirable to substitute a positive term, and the word *heterochiry* [1] is proposed. The walk, the trot and the rack are heterochiral, since the fore foot is followed, not by its fellow, but by a hind foot. When the hind foot alternates with the fore foot of the same side *lateral heterochiry* occurs. When with the fore foot of one side the hind foot of the opposite side alternates, *diagonal heterochiry* takes place.

In connection with the terms flexion and extension the following will be used:— The movement of a limb against the medium in which the animal is moving constitutes the "*stroke.*" The movement in preparation of the stroke constitutes the "*recover.*" In the description of the "hand over hand" movements of the sloth and the monkey, the word "flexion" has no place; yet the "recover" is used in as exact a sense as in the movements of any other animal.

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[1] While assuming the responsibility for this word the writer desire at the same time to say that it was suggested to him in a conversation with his friend Prof. T. N. Gill.

When a limb of a terrestrial quadruped rests upon the ground it may be said be "on," and when not on the ground, to be "off."

The term "*sura*" will be employed as a convenient word to include the hind limb from the knee to the ankle. "*Crus*" has been retained so generally as a synonym for the entire posterior extremity as not to be available.

"Stroke" is the period of impact. It is included in flexion, and constitutes its first stage. "Recover" embraces the last stage of flexion and the whole of the period of foreward movement. The terms "stroke" and "recover" are by no means the same as flexion and extension. They simply express certain phases of limb-function which are seen during the acts of backward and foreward movements.

THE POSITION OF LIMBS.

In studying the motions of the limb of a vertebrate the position which answers to that taken by the salamander, when at rest, is assumed to be the best adapted for comparison. In this position the limb is horizontal to the plane of the longitudinal axis of the body. The venter of the body and the ventral surface of the limb are on the same plane nearly. The limb of a reptile varies scarcely at all from that just named. When a terrestrial animal is erect the limb instead of being on the same plane with that of the body is moved a quarter of a circle downward. In the bird the posterior extremity when at rest is in the same position as the terrestrial, but the anterior extremity, in marked contrast to it, is flexed. When extended the extremity is thrown upward to a position as far removed from the horizontal position of the salamander in one direction as is that of the terrestrial quadruped in the other.

In the movement of all limbs the directions in the main are forward and backward. Both the movements are oblique but between them is a position which is straight. In the terrestrial animal this position may be said to answer to a line in the anterior extremity which lies immediately in advance of the withers and in the posterior extremity to the centre of the acetabulum.

THE MOVEMENTS OF LIMBS.

If a limb can be conceived moving *in vacuo* it can be at once understood that propulsion is impossible. For propulsion can follow only upon the initiation of an impetus and this in turn only by the resistance of the limb against the medium in which the animal

is moving, or in the case of the terrestrial animal, the surface of the ground.

The resistance of the air and the water are so much less than that of the earth that the acts of flying and of swimming become radically different from those of walking, of running, or of any allied movement. In flying and swimming the resistance made by the limb against the medium in effecting an impetus does not arrest the movement of the pinion or the foot; whereas in terrestrial movements the instant that the foot strikes the earth the resistance is great and the arrest is complete.

In the swimming turtle the first stage of the recover drives the foot in spite of the resistance of the water to the point at which the second stage begins. With some slight modifications the same is true of fossorial animals. Thus in flying, in swimming, and in burrowing the limb describes a continuous movement which unites the path of the stroke to that of the recover. In the animal moving on the surface of the ground, the foot being brought to rest, an absolute break occurs between the beginning of the act of recover and its completion,—the time which would be required to describe the interval and thus to complete the union corresponds to the period that the foot is on the ground. This period constitutes the stroke.

The limb rests on the ground until the trunk moves beyond the point at which it can maintain itself. It is lifted at intervals which are dependent upon the momentum of the moving mass. One, two, or three limbs may be on the ground at the same time. The rates at which the succession of the foot-falls occur, in their turn, depend not only upon the rate of speed at which the animal is moving, but on the gait as well.

KINDS OF WORK DONE BY THE LIMBS.

The kinds of work done by the limbs are two in number, viz., that done by the fore limbs and that done by the hind limbs. The hind limbs are more powerful than the fore limbs, and in some animals, as the kangaroo and the jumping mouse, are the main effectives. No terrestrial animal depends for support upon the fore limbs. When all the limbs are equal or nearly equal in length, the preponderance is still in favor of the hind limbs owing to the fact that the great backward movement of these limbs on the trunk is made possible by the fixation of the bones to the pelvis and through this structure to the vertebral column. Not only is this the case but the hind limbs alone possess the power of propelling the body so as to throw upon the

fore limbs the labor of accommodatiug themselves to the rate of work of their more powerful associates. When an animal is moving at a high rate of speed, as in the gallop, the synchiral action of the hind limbs projects the body with such force as to compel the fore limbs to act simply as props which successively carry the body forwards until one of the hind limbs is again in position to give the body a second impetus. In proof of this assertion it is only necessary to observe that the greatest height attained by the trunk is that secured by the rump when both hind feet are off the ground. The statement generally made that the horse leaves the ground by one of the fore feet creates the impression that he gains the springing force from this foot, all the previous movements being in preparation for such a spring. In place of this statement another is here substituted, viz., that the horse springs from that hind foot which last leaves the ground and is "off" from all feet when he simply relinquishes the support afforded by the last prop, that is to say the last fore foot.

If the fore and hind limbs were based on the same plan the motion of an animal would be either a series of springs—the two feet pushing against the ground at the same moment—or a series of steps, the two feet moving alternately. While closely resembling one another the two limbs are not on the same plan. If any motion takes place in the vertebral column at the time that the fore limb is moving it is noticed that it occurs in the region of the neck. The scapula has a slight motion downward and backward. The motion in the hind limbs occur in the region of the lumbar vertebræ while the pelvic bones are fixed. The limit of the forward motion of the hind limbs is dependent upon the flexibility of the lumbar vertebræ. The limit of the similar motion of the fore limb is determined by the action of the muscles alone. The forward motion of the fore limbs is essentially the same in all animals; but the forward movement of the hind limbs is variable, because the lumbar vertebræ differ in degrees of flexibility. In unguiculates there is more lumbar flexibility than in ungulates. In backward movements the opposite obtains, for in these positions the fore limbs can be carried back to a variable distance. In the deer and its congeners the fore foot can be brought to a point near the centre of the body, and the limb be vertical. In the horse the fore limb in backward strain is very oblique and the foot while well placed under the trunk cannot reach the centre. In the macaque the fore foot cannot pass beyond a vertical line which intersects the trunk a little back of the shoulder-joint. The backward movement of the hind limb is nearly the

same in all animals. The leg is always carried in a direct path, the limit of the movement being determined solely by the length of the limb. In a word the forward movement is the less constrained in the fore limb while the backward movement is the least constrained in the hind limb. The most variable movements are the backward for the fore-limb and the forward for the hind-limb.

The foot in all animals excepting the horse (and even in this single toed form the movement of the foot is nearly all essentials the same) is carried forward in semipronation. The foot strikes the ground on the outer border. Pronation now begins and is completed by the time the perpendicular line is reached. The foot leaves the ground by the inner border (the toes being successively abducted) so that the pressure of the body is borne from without inward across the foot. The foot is always everted as it leaves the ground. In a plantigrade animal, as the raccoon, the foot is carried during the last part of recover nearly parallel to the plane of support. In the rapid motion of ungulates the foot may actually touch the ground nearly to the hock. In backward strain the hock or heel is gradually raised and at the end of strain the animal is seen touching the ground by the tip of the inner functionally active toe. In the horse the foot leaves by the tip of the hoof. It is likely that the degree of impact of the outer border of the foot will be found to correlate with the degree of development of the calcaneo-sural joint* since the weight must be carried along the outer border to the rest of the limb. At the end of backward strain the limb from the knee distally is in the same line. The moment flexion begins eversion is established, and the limb becomes angulated outward at the ankle. The main axis of the proximal facet of the astragalus is correlative with the degree of this obliquity. It is most pronounced in the horse, less so in the ox, and scarcely at all in the hog.

It has been already seen that when the limb is in the position of arrest and the momentum carries the body beyond the perpendicular line it is thrown into "backward strain." The instant that the strain begins the knee is seen to move outward and the hock to move inward. The parts of the foot below the heel remain unchanged. The impact of the structures of the limb are thus impaired in backward strain. It is well known that in the pentadacyle forms the foot can be readily rotated at the medio-tarsal joint and it is a reasonable

*A name proposed for the joint existing between the fibular process of the calcaneum and the fibula or the tibia.

assumption that it is at this joint that the distal part of the limb moves when the entire limb rotates outward. The femur, the bones of the leg, and the astragalus act as one factor; and the calcaneum and the remaining bones of the foot as the other factor. The socket for the proximal motion occurs at the hip, and that for the distal at the concavity of the scaphoid bone. There is also considerable motion between the calcaneum and the cuboid bone and between the calcaneum and the lower end of the fibula, if this bone is present, or with the outer end of the tibia if it is absent. Outward rotation of the main portion of the limb carries the calcaneum slightly inward by reason of the articulation between the calcaneum and the bones of the leg, Facets are here present in most terrestrial mammals. In the wombat the articulation is evident. It is present in a rudimentary form in man.

The outer surface of the calcaneum of the bear is marked by a stout roughened ridge as it enters into articulation with the fibula. In the dog the surface is a small embossment which probably is in contact with the fibula only at the time of the backward strain. In a single old dog examined the same ridge is present as in the bear. A similar ridge which developed under the stimulus of diseased action is seen in the skeleton of the tiger in the Museum of the Academy.

As the knee is rotated outward the outer border of the foot is slightly inverted. This disposition is opposed by the peroneus longus muscle which everts the foot. Coincident with the inversion the external crucial ligament becomes tense and the tendency to torsion is checked.

The first movement noticed in the limb after it is beyond the centre of gravity is the flexion of the foot. In the horse the hoof is thrown backward and the under surface of the foot is directed backward, the heel being raised first. The sole is next directed upward. In animals possessing more than one functionally active toe the toes are quickly adducted in the air so as to offer the least resistance to the impetus of the entire body. Associated with the above a pronounced flexion of all parts of the limb occurs excepting at the hip, where the movement is slight. A movement of the thigh toward the trunk is indeed discernible. In animals possessing long thigh-bones, such as the elephant, the movement is more decided than in the ungulates. The same remarks are applicable to the movements of the humerus. The degree to which flexion is carried is more marked in the young than in the adult, and in terrestrial than

in arboreal creatures. In the sloth (*Cholœpus*) flexion is absent, the limbs being advanced by a swinging motion at the shoulder and the hip.

The unaided eye receives the impression of backward movement but fails to be impressed with forward movement. It may hence be inferred that the former is a quicker movement than the latter.

In the fore limb the last state of extension of the forearm answers to the action of the extensors of the carpus and of the digits. In the less delicate movements of the hind limb the muscles which extend the tarsus and the toes move the foot with less precision and it is likely with less speed.

Biological Department of the University of Pennsylvania, March 1st, 1887.

MARCH 22.

The President, Dr. LEIDY, in the chair.

Twenty-four persons present.

The following were ordered to be printed:—

A LIST OF THE CARICES OF PENNSYLVANIA.

BY THOS. C. PORTER.

All the species of *Carex* contained in this list are represented in the herbarium of Lafayette College by specimens from all the counties named, with the single exception of *C. Torreyi*. It will be observed, that, contrary to the common usage, the county is put first, the particular station next, and then, the name of the collector, in italics. When the latter is wanting, it indicates that the author himself is the collector.

The order of arrangement and most of the changes in nomenclature are taken from the *Synopsis of North American Carices*, by L. H. Bailey, Jr., published in the Proceedings of the American Academy of Arts and Sciences, 1886.

1. **Carex pauciflora**, Lightf.

SUSQUEHANNA, near Montrose, *Garber*, 1869; WAYNE, Torrey Lake, *Garber*, 1870. Very rare. The southern limit of the species.

2. **Carex subulata**, Michx.

SCHUYLKILL, Broad Mountain, in a bog beside the railroad, in company with the very rare and local *Juncus Smithii*, Engelm., 1866. According to Darlington's *Flora Cestrica*, it has also been found in Chester County.

3. **Carex folliculata**, L.

MONROE, Pocono; LACKAWANNA, Moosic Lake; LUZERNE, Carbondale, *Garber;* SCHUYLKILL; NORTHAMPTON, Pen Argyl; DELAWARE, Tinicum; LANCASTER, Smithville Swamp; CENTRE, Bear Meadows; VENANGO, East Sandy Creek, *Garber*. Common in the mountains, but rare elsewhere.

4. **Carex intumescens**, Rudge.

MONROE, Water Gap, *Knipe*; NORTHAMPTON; BUCKS, (Moyer's Cat.); CHESTER, (Fl. Cestr.); LANCASTER; BLAIR, *Boecking;* ARMSTRONG, *Knipe*.

5. **Carex Grayii,** Carey.

CLEARFIELD, *McMinn,* 1867; MERCER, *Garber,* 1868. DELAWARE, Tinicum, *A. H. Smith,* 1867. Very rare east of the Alleghenies.

6. **Carex lurida,** Wahl. (*C. lupulina,* Muhl.).

MONROE, Water Gap, *Knipe*; NORTHAMPTON; BUCKS, (Moyer's Cat.); DELAWARE, *Dr. George Smith*; CHESTER, (Fl. Cestr.); LANCASTER; FRANKLIN; HUNTINGDON.

7. **Carex lurida,** Wahl., *var.* **polystachya,** Bailey.

CLEARFIELD, *McMinn*; CRAWFORD, Conneaut Lake, *Garber.* Rare. Not known east of the Alleghenies.

8. **Carex oligosperma,** Michx.

CENTRE, in a bog four miles west of Pennsylvania Furnace; CARBON, borders of Round Pond, Aug., 1867. Very rare. The southern limit of the species.

9. **Carex rostrata,** Withering.

MONROE, Tobyhanna Mills and Tunkhannock Creek; ERIE, Presque Isle, *Garber.*

10. **Carex rostrata,** Withering, *var.* **utriculata,** Bailey.

MONROE, *Dr. Traill Green, Moyer*; SULLIVAN, *C. E. Smith*; TIOGA, *Garber;* CENTRE, Bear Meadows; ELK, *McMinn.*

11. **Carex monile,** Tuckerman.

BUCKS, Sellersville, *Fretz;* CHESTER, (Fl. Cestr.); HUNTINGDON, Barrens, *Lowrie;* ELK, *McMinn;* CRAWFORD, *Garber;* MERCER, Middlesex, *Garber.*

12. **Carex Tuckermani,** Boott.

MONROE, Pocono; HUNTINGDON; CLEARFIELD, *McMinn;* MERCER, *Garber.* Rare.

13. **Carex bullata,** Schkuhr.

LANCASTER, Smithville Swamp; LYCOMING, Limekiln Swamp, *McMinn.* Rare and local.

14. **Carex retrorsa,** Schweinitz.

HUNTINGDON, near Pennsylvania Furnace, *Boecking,* 1870. The only station known in the State. The southern limit of the species.

15. **Carex tentaculata,** Muhl.

MONROE; NORTHAMPTON; BUCKS, (Moyer's Cat.); CHESTER, (Fl. Cestr.); LANCASTER; CENTRE; BLAIR, *Boecking;* CLEARFIELD, *McMinn;* CLARION, *Garber.* Common and abundant.

16. **Carex tentaculata,** Muhl., *var.* **gracilis,** Boott.

WAYNE, *Garber;* MONROE; HUNTINGDON; CLEARFIELD, *McMinn.*

17. **Carex Schweinitzii**, Dewey.

MONROE, Pocono, *Schweinitz*. The specimen is from Schweinitz himself, but it does not seem to have been collected in Pennsylvania since his day.

18. **Carex hystricina**, Muhl.

MONROE, Water Gap, *Knipe;* NORTHAMPTON, Easton; BUCKS, (Moyer's Cat.); CHESTER, (Fl. Cestr.); LANCASTER; FRANKLIN; HUNTINGDON.

19. **Carex Pseudo-Cyperus**, L. ERIE, Presque Isle, *Garber*.

20. **Carex Pseudo-Cyperus**, L, *var.* **comosa**, W. Boott.

WAYNE, *Garber;* PIKE, *Fiot*; NORTHAMPTON, near Easton; BUCKS, *Diffenbaugh*, (Moyer's Cat,); LANCASTER; HUNTINGDON, Alexandria; CRAWFORD, Conneaut Lake, *Garber;* ERIE, Presque Isle, *Garber*.

21. **Carex stenolepis**, Torrey.

HUNTINGDON, near Alexandria; GREENE, Greensboro, *Garber*. Very rare and local.

23. **Carex squarrosa**, L.

BUCKS, *Diffenbaugh;* PHILADELPHIA, *Diffenbaugh;* DELAWARE, *Dr. G. Smith;* CHESTER, (Fl. Cestr.), LANCASTER; HUNTINGDON; CLEARFIELD, *McMinn;* MERCER, *Garber;* ALLEGHENY, *Knipe*.

23. **Carex Shortiana**, Dewey.

FRANKLIN, in meadows around Mercersburg. The only station known in the State. Its northern and eastern limit.

24. **Carex scabrata**, Schweinitz.

WAYNE, *Garber;* CARBON; NORTHAMPTON; BUCKS, (Moyer's Cat.); Philadelphia, on the Wissahickon, *C. E. Smith* and *Dr, Jos. Leidy;* LANCASTER; FRANKLIN; SULLIVAN, *C. E. Smith;* BLAIR, *Lowrie*. Along shaded rivulets, especially in the mountains. Not common.

25. **Carex vestita**, Willd.

NORTHAMPTON, Pen Argyl; BUCKS, Bristol, *Diffenbaugh*, (Moyer's Cat.); LANCASTER, Smithville Swamp; CLEARFIELD, *McMinn;* CAMERON, *McMinn*. Rare.

26. **Carex filiformis**, L.

WAYNE, *Garber;* MONROE, Water Gap, *Knipe;* ERIE, Presque Isle, *Garber, Guttenburg*. Rare.

27. **Carex filiformis**, L., *var.* **latifolia**, Boeckeler, (*C. lanuginosa*, Michx.)

MONROE, Water Gap, *Knipe;* BUCKS, (Moyer's Cat.); CHESTER, (Fl. Cestr.); BERKS; LANCASTER; FRANKLIN; ELK, *McMinn*.

28. **Carex trichocarpa,** Muhl.

MONROE, Water Gap, *Knipe;* BUCKS, (Moyer's Cat.); LANCASTER; FRANKLIN; CENTRE, *Boecking;* ELK, *McMinn.*

29. **Carex riparia,** W. Curtis. (*C. lacustris,* Willd.)

WAYNE, *Garber;* BUCKS, *Garber;* DELAWARE, Tinicum, *A. H. Smith;* TIOGA, *Garber;* ELK, *McMinn.* Rare.

30. **Carex Buxbaumii,** Wahl.

LEHIGH, near Mountainville; BUCKS; LANCASTER; FRANKLIN. Rare.

31. **Carex vulgaris,** Fries.

MONROE, Water Gap, *Knipe;* CENTRE, *McMinn.* Very rare. Its southern limit.

32. **Carex aquatilis,** Wahl.

ERIE, Presque Isle, *Guttenberg.*

33. **Carex stricta,** Lamarck.

WAYNE, *Garber;* MONROE; NORTHAMPTON; CHESTER, (Fl. Cestr.); BERKS, *Garber;* LANCASTER; FRANKLIN; ELK, *McMinn.* Very common and variable; growing in marshy places in tussocks,

34. **Carex aperta,** Boott.

BUCKS, *Moyer, Fretz;* LYCOMING, *A. H. Smith, McMinn.* Rare.

35. **Carex torta,** Boott.

NORTHAMPTON, *Fiot;* BUCKS, Nockamixon Rocks; CHESTER, *Canby;* FRANKLIN; PERRY, *Garber;* SULLIVAN, on the Loyalsock, *C. E. Smith;* HUNTINGDON; BLAIR, Burgoon's Gap; CLEARFIELD, Sandy Lick, *McMinn;* ELK, *McMinn.* Along the margins and often in the beds of rivulets, in shaded, rocky ravines. Sometimes the fertile spikes are much crowded and much branched (var. *composita,* Porter), giving the plant a singular appearance, as if, to use the phrase of Mr. Canby, it had "run mad."

36. **Carex prasina,** Wahl. (*C. miliacea,* Muhl.)

NORTHAMPTON; BUCKS, (Moyer's Cat.); PHILADELPHIA, *Dr. J. Leidy;* CHESTER, (Fl. Cestr.); BERKS, *Dr. J. P. Hiester;* LANCASTER; SULLIVAN, *A, H. Smith;* ELK, *McMinn.*

37. **Carex crinita,** Lamarck.

MONROE; NORTHAMPTON; BUCKS, (Moyer's Cat.); CHESTER, (Fl. Cestr.); LANCASTER; ELK, *McMinn.*

38. **Carex crinita,** Lam., *var.* **gynandra,** Schw. and Torr.

WAYNE, *Garber;* LACKAWANNA; LUZERNE, *Garber;* MONROE, Pocono; SCHUYLKILL; NORTHAMPTON, Seidersville, *R. G. Bechdolt;* CHESTER, Landenberg, *Canby;* TIOGA, *Garber;* CLEARFIELD,

McMinn; ARMSTRONG, *Garber.*—Common in the mountains, but rare elsewhere.

39. Carex Magellanica, Lamarck. (*C. irrigua,* Smith.)

MONROE, on the Tunkhannock, *Dr. Traill Green,* June, 1861. Very rare. Its southern limit. Since found (in 1886) in the same neighborhood, by Prof. Dudley, who writes, "The unusually obtuse perigynia more resemble those of the Fuegian specimens figured by Boott than those of any other specimens or figures I have access to."

40. Carex limosa, L.

WAYNE, *Garber*; MONROE, Pocono; TIOGA, *Garber;* BUCKS, Sellersville, *Moyer.*—Rare. Chiefly in sphagnous bogs on the mountain-plateaus.

41. Carex virescens, Muhl.

MONROE, *Knipe;* NORTHAMPTON, around Easton; BUCKS, *Fretz;* PHILADELPHIA, *Diffenbaugh;* DELAWARE, *A. H. Smith;* MONTGOMERY, *Diffenbaugh;* LANCASTER; FRANKLIN.—Common.

42. Carex triceps, Michx.

NORTHAMPTON; BUCKS; PHILADELPHIA; DELAWARE, Tinicum; *A. H. Smith;* CHESTER, (Fl. Cestr.); LANCASTER; FRANKLIN; LYCOMING, *A. H. Smith;* TIOGA, *Garber;* BLAIR, *Boecking.* A common and variable species.

43. Carex Smithii, Porter. (*Olney, Exsicc., fasc.* 1, *no.* 28.)

Glabrous, except the sheaths of the narrowly-linear leaves; culms slender, erect, 1 to 2 feet high; fertile spikes 2 to 4, short-cylindrical, nearly sessile, approximate; perigynia globular, contracted to a manifest point, crowded but not imbricated, smooth, a little longer than the ovate, brownish, mucronate scales; akenes broadly-pyriform, with very short, abrupt, inflexed tips.—CHESTER; DELAWARE, Tinicum and Pusey's Woods, *A. H. Smith.*

In shape and appearance, the spikes, perigynia and akenes, and the olive-green hue of the plant, at first sight, suggest *C. granularis* rather than *C. triceps.*—It is named in honor of Mr. Aubrey H. Smith of Philadelphia. Just beyond our borders, Mr. Canby reports it as "very common in fields and woodlands around Wilmington, Delaware," and specimens from Gloucester, N. J. were sent me by the late Chas. F. Parker. It is certainly a well-marked variety, if not a distinct species.

44. Carex longirostris, Torrey,

LYCOMING, near Williamsport, *McMinn;* MONROE, Water Gap, *Knipe;* BUCKS, Nockamixon Rocks, *Garber.* Rare and local. Its southern limit.

45. **Carex arctata,** Boott.

MONROE, Pocono, *Dr. Traill Green;* SULLIVAN, *Chas. E. Smith;* BLAIR, *Boecking;* ELK, *McMinn.*—Rare. Its southern limit.

46. **Carex debilis,** Michx.

MONROE, Pocono; NORTHAMPTON; BUCKS, (Moyer's Cat.); DELAWARE, *A. H. Smith;* CHESTER, (Fl. Cestr.); LANCASTER, Smithville Swamp; CENTRE, Bear Meadows, *Lowrie;* HUNTINGDON; BLAIR, *Boecking;* CLEARFIELD, *McMinn;* MERCER, *Garber.*

47. **Carex debilis,** Michx., *var.* **pubera,** Gray.

CENTRE, Bear Meadows, *Lowrie;* LANCASTER, Smithville Swamp. Very rare and local.

48. **Carex aestivalis,** M. A. Curtis.

CHESTER. (Fl. Cestr.); LACKAWANNA, Carbondale, *Garber;* SULLIVAN, *C. E. Smith;* TIOGA, *Garber.*—Rare.

49. **Carex gracillima,** Schweinitz.

LEHIGH, *Garber;* NORTHAMPTON; BUCKS, (Moyer's Cat.); CHESTER, (Fl. Cestr.); LANCASTER; FRANKLIN; BLAIR, *Boecking.* Common.

50. **Carex Davisii,** Schw. & Torr.

NORTHAMPTON; BUCKS, (Moyer's Cat.); CHESTER, (Fl. Cestr.); LANCASTER; FRANKLIN, Mercersburg.—Rare.

51. **Carex grisea,** Wahl.

MONROE, Water Gap, *Knipe;* NORTHAMPTON, Easton; BUCKS, (Moyer's Cat.); CHESTER, (Fl. Cestr.); LANCASTER; FRANKLIN; BLAIR; ALLEGHENY, *Knipe.*—Common.

52. **Carex glaucodea,** Tuckerman.

NORTHAMPTON, Easton, Pen Argyl, Bethlehem, *Fiot;* BUCKS, Nockamixon Rocks, marshes near Quakertown; DELAWARE, Pusey's Woods, *A. H. Smith;* LANCASTER; LYCOMING, *McMinn.*—I first met with this species in a swamp near Smithville, Lancaster County, in 1863. It struck me at once as new, and specimens, name and distinctive characters were sent to Col. Olney, who informed me that it had also been discovered near Amherst, Mass., and that Prof. Tuckerman had just described it and his description would soon appear in the Proceedings of the American Academy of Arts and Sciences. Since then, it has been found at a number of stations in Eastern Pennsylvania and the neighboring States. In 1880, I collected it on the summit of Roane Mtn., N. C.

53. **Carex granularis,** Muhl.

NORTHAMPTON; BUCKS, (Moyer's Cat.); CHESTER, (Fl. Cestr.);

LANCASTER; FRANKLIN, Mercersburg.—Common.

54. Carex granularis, Muhl., *var.* **Haleana,** (*C. Haleana*, Olney. Exsiccat. fasc. iii, no. 14.)

Glabrous; leaves broad and very glaucous; culms and peduncles slender and weak; fertile spikes much smaller and shorter; perigynia less than half the usual size, rather narrowly ovoid, not globular.

NORTHAMPTON, near Easton; LANCASTER, Smithville Swamp; ALLEGHENY, *Knipe.*—Outside of our limits, it has been collected at Madison, Wisc., by *T. J. Hale,* and in Montgomery County, Va., by *Dr. Joseph Leidy.*

55. Carex flava, L.

CRAWFORD, Conneaut Lake, *Garber.*—The only station known.

56. Carex Œderi, Retz.

ERIE, Presque Isle, *Garber.*—The only station known.

57. Carex pallescens, L.

WAYNE, *Garber;* LACKAWANNA, Carbondale, *Garber;* CLINTON, *McMinn.*—Rare. The southern limit of the species.

58. Carex Torreyi, Tuckerman.

Specimens of this rare species are reported as existing in European herbaria, collected by Schweinitz near Bethlehem, Penna., and named by him *C. abbreviata.* This may be correct, but among his plants, now in possession of the Philadelphia Academy, there is a sheet, at the top of which he has written "*Carex lanosa—abbreviata,*" and at the bottom, "Bethlehem." The eight or ten specimens on the sheet, fastened down with paper-strips, are all *C. vestita,* Willd. Although sought for in his old haunts, *C. Torreyi* has not yet been rediscovered.

59. Carex conoidea, Schkuhr.

MONROE, Water Gap, *Knipe;* NORTHAMPTON; BUCKS; DELAWARE, *Canby;* BERKS, near Reading; LANCASTER; FRANKLIN; LYCOMING, *McMinn.*

60. Carex oligocarpa, Schkuhr.

NORTHAMPTON, Easton; BUCKS, Sellersville, *Fretz;* LANCASTER, on the Conestoga.—Rare.

The specimens of Dr. Fretz exactly agree with those of Dr. Sartwell from Penn Yan, W. N. York, and I cannot see in them any likeness to the southern narrow-leaved variety of *C. grisea,* to which they have been referred.

61. Carex Hitchcockiana, Dewey.

NORTHAMPTON, Easton; LANCASTER; ALLEGHENY, *Knipe.* Rare.

62 **Carex laxiflora,** Lamarck.
BUCKS, (Moyer's Cat.); LANCASTER; BLAIR, *Lowrie.*

63. **Carex laxiflora,** Lam., *var.* **styloflexa,** Boott.
LEHIGH, *Garber;* NORTHAMPTON, Bethlehem; BUCKS, *Garber;* BERKS, Neversink Mtn.; DELAWARE, Tinicum, *A. H. Smith.*—Rare.

64. **Carex laxiflora,** Lam., *var.* **patulifolia,** Carey.
MONROE, Water Gap, *Knipe;* NORTHAMPTON; LANCASTER; HUNTINGDON; ALLEGHENY, *Knipe.*

65. **Carex laxiflora,** Lam., *var.* **intermedia,** Boott.
NORTHAMPTON; BUCKS, (Moyer's Cat.); FRANKLIN, LUZERNE, *Garber;* LYCOMING, *McMinn;* MERCER, *Garber.*

66. **Carex laxiflora,** Lam., *var.* **striatula,** Carey.
NORTHAMPTON; BUCKS, (Moyer's Cat.); DELAWARE, *Diffenbaugh;* LANCASTER.

67. **Carex laxiflora,** Lam., *var.* **latifolia,** Boott.
BUCKS, Nockamixon Rocks; LANCASTER; ALLEGHENY, *Garber.*

68. **Carex retrocurva,** Dewey.
NORTHAMPTON; BUCKS, *Moyer;* LANCASTER; FRANKLIN; CENTRE, *Boecking.*—Rare.

69. **Carex digitalis,** Willd.
NORTHAMPTON; BUCKS, (Moyer's Cat.); DELAWARE, *Dr. G. Smith;* CHESTER, (Fl. Cestr.); LANCASTER; TIOGA, *Garber;* CLEARFIELD and ELK, *McMinn.*

70. **Carex platyphylla,** Carey.
MONROE, Water Gap, *Knipe;* BUCKS, Nockamixon Rocks; CHESTER, Black Rock Tunnel, *Diffenbaugh;* LANCASTER; SULLIVAN, *C. E. Smith;* CENTRE, *Boecking;* ALLEGHENY, *Knipe.* Rare.

The *C. platyphylla* of Darlington's Flora Cestrica is probably *C. laxiflora,* Lam.

71. **Carex Careyana,** Torrey.
ALLEGHENY, *Knipe.*—From one station only.

72. **Carex plantaginea,** Lamarck.
BUCKS, Nockamixon Rocks; CHESTER, near Phœnixville, *Martindale;* SULLIVAN, on the Loyalsock, *C. E. Smith;* BLAIR, *Lowrie;* CLEARFIELD, *McMinn;* ALLEGHENY, *Knipe.*—Rare and local.

73. **Carex polymorpha,** Muhl.
MONROE, Pocono; BUCKS, (Moyer's Cat.); LANCASTER, Smithville Swamp; CLINTON, *McMinn.*—Rare and local.

74. **Carex tetanica,** Schkuhr.
MONROE, Water Gap, *Knipe;* NORTHAMPTON, Easton; BUCKS,

(Moyer's Cat.); LANCASTER; FRANKLIN.

75. Carex tetanica, Schkuhr, *var.* **Canbyi.** (*C. panicea*, L., *var. Canbyi*, Olney, *Exsicc. fasc.* ii, nos. 24 and 25.)

Taller, erect and more robust than the type. The fertile spikes and perigynia larger. In the last edition of Gray's Manual, it is placed under *C. panicea*, L., but Mr Bailey makes it identical with *C. Meadii*, Dew., from which it differs in its blunt scales and habit of growth.

76. Carex tetanica, Schkuhr, *var.* **Carteri.**

LANCASTER, New Texas, *J. J. Carter*, June, 1862.—Glabrous, 15 to 20 inches high; staminate spikes on shorter stalks; pistillate spikes 2 to 3, oblong, erect, all staminate at the apex; lower bract equalling the culm; perigynia ovoid, obtuse, straight or straightly curved above, not pointed, twice the length of the blunt scales.—Named for the discoverer.

77. Carex Meadii, Dewey.

BUCKS, *Dr. I. S. Moyer*.—Very rare. It exactly accords with Western specimens received from Dr. Mead and Mr. Bebb.

78. Carex Crawei, Dewey.

CLINTON, *McMinn*.—The only station known.

79. Carex aurea, Nutt., *var.* **androgyna,** Olney.

ERIE, Presque Isle, *Garber*.—The only station known.

80. Carex eburnea, Boott.

NORTHAMPTON, near Easton.—On shaded limestone rocks; in dense mats, and abundant. The only station known.

81. Carex pedunculata, Muhl.

BUCKS, (Moyer's Cat.); BERKS, *Dr. J. P. Hiester;* LANCASTER; FRANKLIN; SULLIVAN, *C. E. Smith;* JEFFERSON, *McMinn;* ERIE, Presque Isle, *Guttenberg*.—Rare.

82. Carex Pennsylvanica, Lamarck.

NORTHAMPTON; BUCKS, (Moyer's Cat.); CHESTER, (Fl. Cestr.); LANCASTER; CLEARFIELD, Sandy Ridge, *McMinn*.—Far less common than the next species.—In the specimens of Mr. Mc Minn, the leaves are from 2½ to 3 lines wide, and the scales and perigynia deep chestnut-brown.

83. Carex varia, Muhl.

MONROE; BUCKS, (Moyer's Cat.); BERKS, *Diffenbaugh*; SCHUYLKILL; LANCASTER; FRANKLIN; SULLIVAN, *C. E. Smith;* BLAIR, *Lowrie;* CLEARFIELD, *McMinn*.

84. Carex Emmonsii, Dewey.

NORTHAMPTON; BUCKS, (Moyer's Cat.); PHILADELPHIA; LAN-

CASTER; ALLEGHENY, *Knipe*.

85. Carex nigro-marginata, Schweinitz.

NORTHAMPTON, Seidersville, *R. G. Bechdolt*: BUCKS, *J. A.* and *H. F. Ruth*.—Rare and local.

86. Carex umbellata, Schkuhr.

NORTHAMPTON; BUCKS; CARBON, *Garber;* LYCOMING, *A. H. Smith;* PHILADELPHIA, Manayunk, *C. E. Smith;* LANCASTER, Chickies.—On dry rocks and hillsides. Not common.

87. Carex pubescens, Muhl.

NORTHAMPTON; BUCKS, (Moyer's Cat.); DELAWARE, *Dr. G. Smith;* CHESTER, (Fl. Cestr.); BERKS, *Dr. J. P. Hiester;* LANCASTER; CLEARFIELD and ELK, *McMinn*.

88. Carex Willdenovii, Schkuhr.

NORTHAMPTON; BUCKS, Nockamixon Rocks; LANCASTER; LYCOMING, *A. H. Smith*.—Rare.

89. Carex Steudelii, Kunth.

LANCASTER, on the Conestoga; DAUPHIN, near Harrisburg, *Garber*; ALLEGHENY, *Knipe*.—Rare.

90. Carex polytrichoides, Muhl.

MONROE, Water Gap, *Knipe;* NORTHAMPTON; CHESTER, (Fl. Cestr.); LANCASTER; FRANKLIN; SULLIVAN, *C. E. Smith;* HUNTINGDON.—Common, in wet meadows.

91. Carex chordorhiza, Ehrhart.

TIOGA, Marsh Farm, near Wellsborough, *Garber*, 1869.—Very rare. The only station known. Its southern limit.

92. Carex conjuncta, Boott.

PHILADELPHIA, on the Schuylkill, *Canby*.—No other station known.

93. Carex stipata, Muhl.

WAYNE, *Garber;* NORTHAMPTON; BUCKS, (Moyer's Cat.); PHILADELPHIA, *Diffenbaugh;* CHESTER, (Fl. Cestr.); LANCASTER; SULLIVAN, *C. E. Smith*; CENTRE, *Boecking;* HUNTINGDON; ALLEGHENY, *Knipe*.—One of our most common and abundant species.

94. Carex teretiuscula, Gooden.

TIOGA and CRAWFORD, *Garber*.—Rare.

95. Carex teretiuscula, Gooden., *var.* **ramosa,** Boott.

LANCASTER, Dillerville Swamp; CENTRE, *Boecking*.—Rare.

96. Carex vulpinoidea, Michx.

NORTHAMPTON, BUCKS; LANCASTER; FRANKLIN; TIOGA, *Garber;* HUNTINGDON; BLAIR.—Exceedingly common and very variable.

97. Carex alopecoidea, Tuckerman.

CLEARFIELD and ELK, *McMinn*, 1868.—Very rare.

98. Carex disticha, Hudson.

ERIE, Presque Isle, *Garber*.—No other station known.

99. Carex tenella, Schkuhr.

TIOGA, *Garber;* ELK, *McMinn*.—Probably not infrequent in high mountain-bogs, along our northern border.

100. Carex rosea, Schkuhr.

MONROE, *Knipe*; NORTHAMPTON, Easton; LANCASTER; FRANKLIN.

101. Carex rosea, Schk., *var.* **radiata,** Dewey.

WAYNE, *Garber;* MONROE, Water Gap, *Knipe;* BUCKS, (Moyer's Cat.); CHESTER, (Fl. Cestr.); LANCASTER; FRANKLIN; CLEARFIELD, *McMinn*.—Common.

102. Carex rosea, Schk., *var.* **retroflexa,** Torrey.

WAYNE, *Garber;* NORTHAMPTON, Easton; LANCASTER.—Rare.

103. Carex sparganioides, Muhl.

NORTHAMPTON; BUCKS, (Moyer's Cat.); PHILADELPHIA, *Diffenbaugh*; LANCASTER; FRANKLIN; ALLEGHENY, *Knipe*.

104. Carex Muhlenbergii, Schkuhr.

MONROE, Water Gap, *Knipe*; NORTHAMPTON, Easton, Seidersville, *Bechdolt*; BUCKS, (Moyer's Cat.); CHESTER, (Fl. Cestr.); FRANKLIN; HUNTINGDON, *Lowrie*; LYCOMING and CLEARFIELD, *McMinn;* ALLEGHENY, *Knipe*.

105. Carex Muhlenbergii, Schk., *var.* **enervis,** Boott.

PHILADELPHIA, Woodlands, *Canby*.—Very rare.

106. Carex cephalophora, Muhl.

MONROE, Water Gap, *Knipe*; NORTHAMPTON; BUCKS; PHILADELPHIA, *Leidy*; LANCASTER; FRANKLIN; CLEARFIELD and ELK, *McMinn*.

107. Carex cephalophora, Muhl., *var.* **angustifolia,** Boott.

ERIE, Presque Isle, *Garber*.

108. Carex echinata, Murray, (*C. stellulata*, Gooden.), *var.* **conferta,** Bailey.

WAYNE, *Garber*; SCHUYLKILL, Broad Mtn.; LYCOMING, *McMinn*; LANCASTER, New Texas, *J. J. Carter*.

109. Carex echinata, Murr., *var.* **microstachys,** Boeckeler.

MONROE, Water Gap; *Knipe;* NORTHAMPTON; BUCKS, (Moyer's Cat.); CHESTER, (Fl. Cestr.); BERKS, near Reading; LANCASTER.

110. Carex canescens, L.

WAYNE, *Garber;* MONROE, Pocono; SCHUYLKILL; SULLIVAN,

Lake Mtn., *A. H. Smith;* JEFFERSON, *McMinn.*—Peat-bogs, in the mountains.

111. **Carex canescens**, L., *var.* **alpicola**, Wahl.

MONROE, Pocono, *Dr. Traill Green;* WAYNE, *Garber;* CENTRE, Bear meadows, *Lowrie.*—Rarer than the type.

112. **Carex trisperma**, Dewey.

WAYNE, *Garber;* MONROE, Water Gap, *Knipe;* SCHUYLKILL; SULLIVAN, *C. E. Smith.*—Frequent and abundant in mountain-bogs.

113. **Carex bromoides**, Schkuhr.

MONROE, Tannersville, *Garber;* NORTHAMPTON; BUCKS, *Moyer;* CHESTER, (Fl. Cestr.); FRANKLIN; SULLIVAN, *A. H. Smith;* HUNTINGDON; JEFFERSON, *McMinn.*

114. **Carex Deweyana**, Schweinitz.

SULLIVAN, *C. E.* and *A. H. Smith;* ERIE, Presque Isle, *Garber.* Very rare.

115. **Carex siccata**, Dewey.

NORTHAMPTON, Bethlehem, *Fiot.*—The only station known.

116. **Carex tribuloides**, Wahl. (*C. lagopodioides*, Schk.);

NORTHAMPTON; BUCKS, (Moyer's Cat.); CHESTER, (Fl. Cestr.); LANCASTER; TIOGA, *Garber*; HUNTINGDON; BLAIR, *Lowrie.*—Common.

117. **Carex tribuloides**, Wahl., *var.* **cristata**, Bailey.

NORTHAMPTON; LANCASTER; LYCOMING, *McMinn;* HUNTINGDON. Scarcer than the type.

118. **Carex scoparia**, Schkuhr.

MONROE, Pocono; BUCKS, (Moyer's Cat.); LANCASTER; BLAIR, *Boecking*; ALLEGHENY, *Knipe.*—Very common.

119. **Carex adusta**, Boott.

MONROE, Pocono; LACKAWANNA, Carbondale, *Garber;* NORTHAMPTON, Easton; BUCKS, *Moyer;* VENANGO, East Sandy Creek, *Garber.*—Rare.

120. **Carex straminea**, Schkuhr.

NORTHAMPTON; BUCKS, (Moyer's Cat.); CHESTER, (Fl. Cestr.); LANCASTER; FRANKLIN; BLAIR; CLEARFIELD, *McMinn.*—Very variable.

121. **Carex straminea**, Schk., *var.* **aperta**, Boott.

LYCOMING, *A. H. Smith;* ELK, *McMinn.*—Rare.

122. **Carex alata**, Torrey.

MONROE, Pocono Summit, on the D. and L. R. R.—Not known elsewhere.

Two more species have been assigned to our flora, but they lack confirmation.

Mr. Bailey, in his Synopsis, makes the range of *C. gynocrates* extend into Pennsylvania, without mention of any station or collector. It may be looked for in the northern tier of counties along the N. York line.

Muhlenberg, in his *Descriptio uberior Graminum* etc., p. 265. under *C. lagopus?*, which is *C. Fraseri*, Andrews, adds these words, "*Habitat in Tyger-Valley Pennsylvaniae, unde siccam habeo et vivam.*" Kin, the German gardener who collected in S. W. Pennsylvania, brought it home and his label reads thus, " Deigher Walli in der Wilternus." Dr. Gray has shrewdly conjectured that by "Deigher Walli," or Tyger Valley, is meant Tygart's Valley, which lies further south, in Virginia. When the late Dr. Garber visited Fayette and Greene counties, in the service of the College, he made, by my direction, particular inquiry after a valley of that name, but no one had heard of it Yet he discovered there, on our side of Mason and Dixon's line, *Aristolochia Sipho*, and, a little further north, in the same range, occurs *Pyrularia oleifera*, so that it is not at all unlikely, that, some day, this rare and most singular *Carex* will be found lurking in one of the lateral valleys or ravines along the western slope of Chestnut Hill.*

The list above given comprises 98 species and 24 varieties,–a goodly number, which may be increased somewhat. The sending to him of any new or rare species, or specimens of those more common, from the counties not thoroughly explored, will be accounted by the author as a special favor, and duly acknowledged.

The following European species have been collected by Mr. Isaac Burk on the ballast-grounds at Philadelphia—*C. Davalliana*, Lam., *C. distans*, L; *C. hirta*, L. and *C. ornithopoda*, With.

Easton, Penna., March 4th., 1887.

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* A box containing the Carices of Muhlenberg has just been discovered in the Herbarium of the Academy, Philadelphia, and the label attached to the specimens of Kin's collection places Tyger Valley "*prope amnem Kenahway.*"

MARCH 29.

The President, Dr. LEIDY, in the chair.

Twenty-seven persons present.

The death of Pierre Munzinger, a member was announced.

The following were elected members:—

William P. Wilson, Richard B. Westbrook, Albert W. Vail, George O. Praetorius and William Blasius.

Prof. W. K. Brooks of Baltimore was elected a correspondent.

The following was ordered to be printed:—

THE SUMMIT PLATES IN BLASTOIDS, CRINOIDS, AND CYSTIDS, AND THEIR MORPHOLOGICAL RELATIONS.

BY CHARLES WACHSMUTH AND FRANK SPRINGER.

Messrs. Robert Etheridge Jun. and Dr. P. Herbert Carpenter, have recently published, under the auspices of the Trustees of the British Museum, a most important and valuable contribution to palaeontological research, in the form of a memoir, which is in effect a Monograph of the British Blastoids.* The work is marked by a thoroughness and wealth of illustration, characteristic of the scientific publications on special subjects issued under the patronage of the British Goverment, which makes us wish that the facilities offered by our own government in that direction might be a little more extensive. The high reputation of the authors is such an ample guarantee of scientific excellence in the execution of the work, that it is scarcely necessary to do more than allude to the fact of its appearence. The points as to which we should venture to differ with the authors are but few; upon these, however, we regret we find ourselves materially at variance with their views.

The whole of chapter IV, from p. 66 to 74 inclusive, is devoted to a discussion of the summit plates and their morphological relations. The authors undertake to prove that while the summit plates in the Blastoids do not present, as a rule, any very definite arrangement (p. 118), yet they exhibit a series of variations in number and position, in some degree corresponding with a similar but more extensive series of variations among the Palaeocrinoidea; that both exhibit a transition from five closely united plates fully covering the summit, to a set of six proximal plates surrounding a central one. The six proximal plates are held by them to be the homologues of the five oral plates of the Neocrinoidea—a theory to which the division of the proximals into six or more has always interposed a very serious difficulty. If such a transition from five closely fitted plates to six or more around another could be established, of course its tendency would be to diminish the diffi-

*Catalogue of the Blastoidea in the Geological Department of the British Museum (Natural History), with an Account of the Morphology and Systematic Position of the Group, and a Revision of the Genera and Species, By Robert Etheridge Jun. and P. Herbert Carpenter, D. Sc., F. R. S., P. L. S.-4 to.-Pp. I-XVI, 1-322; 20 plates. London. Printed by order of the Trustees, 1886.

culty; but it remains to be seen how far the authors have succeeded in proving it.

A covering of the summit openings in various genera has been described by several writers. This has been generally considered as representing the same structure in all these genera; whereas there is to be found among the coverings, thus described, two distinct structures,. which are totally different from each other, and are characteristic, so far as observed, of distinct groups of the Blastoidea.

The first of these of which any detailed account has been attempted, was observed by Roemer in 1851, in *Elaeacrinus Verneuili*,* which he described as having the summit plates closed by a hexagonal central plate, surrounded by six others, four of equal size and two smaller. Shortly afterwards Shumard,[1] in describing his new species *Pentremites Sayi*, stated that "the central opening is closed by minute, usually pentagonal and hexagonal plates, arranged in a manner somewhat similar to those of *Pentremites* (*Elaeacrinus*) *Verneuili*," and he added in a note:—"the same structure occurs in *Pentremites Norwoodi* and *P. melo* Owen and Shumard, of which I have fully satisfied myself from an attentive examination of many specimens."

In 1863, Dr. White, in a paper on the summit structure of *Pentremites*,[2] confirmed the observations of Shumard as to *Pentremites Norwoodi*, and stated that in this species the whole central space between the summit tubes and the anal aperture "is overlaid with an integument of microscopic plates, entirely covering the central aperture, passing out between the bases of the tubes in a double series of plates, and was evidently continued far down the central grooves of the pseudambulacral fields." He also discovered in *P. stelliformis*[3] a covering of the central summit aperture "essentially the same as in *P. Norwoodii*," and he described it as consisting of "five small plates, arranged like a five pointed star, with the points touching each of the upper ends of the interradial plates, thus completely covering the summit aperture."

Figures of the summit plates of *Granatocrinus Norwoodi* and *Orophocrinus* (*Codonites*) *stelliformis* were subsequently published by Meek and Worthen,[4] confirming the observations of Shumard and

*Archiv f. Naturgesch., 1851. Jahrg. XVII, p. 378.

[1] Palaeontology, in Swallow's Geol. Surv. Mo. 1855, p. 186.

[2] Bost. Journ. Nat. Hist. 1863, Vol. VII, No. 4, p. 484.

[3] Ibid. p. 487.

[4] Illinois Geol. Rep., Vol. V. Pl. IV, figs. 2a, 5.

White; and we [5] in 1881 gave a figure of the summit covering in *Schizoblastus* (*Granatocrinus*) *Sayi.*

In 1858, Shumard [6] described what he took to be a somewhat similar covering in a specimen of *Pentremites conoideus*, which he figured and described as having the central stelliform space (mouth) "perfectly closed by six small, microscopic plates, a central one of a pentangular form surrounded by five smaller pentagonal pieces, which unite with the edges of the aperture and form a little dome. The five ovarial openings are each, in like manner, closed, as represented in the figure by six minute polygonal plates, so arranged as to form a little elevation." Shumard's description of *P. conoideus* was endorsed by Billings[1] who copied his figure, but modified it by adding a small pore at each of the five angles, through which, as he thought, the ambulacra entered the interior.

The fact of the closure of the summit opening in the above mentioned species, and in *Pentremites* generally, has on the other hand been denied by Dr. Hambach,[2] who states that the central opening "was never closed by additional plates, as intimated by some authors (Billings and Shumard), although specimens are frequently found (and I have some in my collection) where it appears as if the summit were closed by additional plates, which, on close examination, however, prove to be Bryozoa or ovulum-like bodies." In a subsequent paper he [3] says that Shumard's original specimen of *P. Sayi*, which was figured in the Missouri Report, "proves to have only a covering of minute calc-spar crystals on the summit, leavings of the surrounding matrix, which could easily be removed by applying a moist camel's hair brush to them;" and he adds—"my specimens which show such a covering * * * prove that the covering consists only of fragments of broken up pinnulae which were washed into the ambulacral furrows and remained there."

As to Hambach's general statement that the central opening was never closed by additional plates, he has undoubtedly been misled by the condition of his specimens. We are certain that if he were to examine the numerous specimens in our collection of *Schizoblastus Sayi*, *Granatocrinus Norwoodi*, *G. melo*, *Orophocrinus stelliformis*,

[5] Revision of the Palaeocrinoidea Pt. II, Pl. XIX, fig. 3.

[6] Trans. St. Louis, Acad. Sci. 1858, Vol, I No. 2, p. 243.

[1] Amer. Journ. Sci. 1869, Vol. XLVIII, p. 82.

[2] Trans. St. Louis, Acad, Sci., 1880, Vol. IV, p. 150.

[3] Trans. St. Louis, Acad., Sci., 1884, Vol. IV No. 3, p. 540.

O. conicus, *O. fusiformis*, an undescribed *Mesoblastus* from New Mexico—to say nothing of *Elaeacrinus* from various localities, and of three different species—all having the central opening perfectly closed by plates, he would come to a different conclusion. We have found *Schizoblastus Sayi* in especially good preservation, with summit plates firmly attached and unincumbered by deposition of fragments of any kind. It is by no means rare to find specimens of this species, in which the summit plates and portions of the covering pieces are in place. They may be seen in several collections in Burlington, and these parts may be vigorously brushed with the stiffest bristles with entire safety. The same may be said of all the above named species, and there can be no sort of question that a plated covering does actually exist in all of them.

With regard to the type specimen of *Pentremites conoideus*, however, we are fully convinced that Hambach is right, and that his definition of the so called plates described and figured by Shumard as covering the center and ovarial openings, as "ovulum-like bodies," for which he was somewhat sharply ridiculed by Dr Carpenter [1] is a perfectly correct statement. The species occurs abundantly at Spurgen Hill, Ind. in a friable, light-colored oolitic limestone, which is composed almost entirely of minute organisms, small bivalves, Gasteropods, etc., and these are interspersed profusely with small egg-shaped bodies of almost uniform size. Nearly every specimen of *Pentremites* from that locality has some of these bodies exposed at the openings, but we find nowhere any regularity in their arrangement, and they are seen equally plain in much worn and weathered specimens.

Prompted by a strong desire to examine Shumard's type, the specimen from which his figure was made, we applied to Dr. Hambach for the loan of it from the Museum of the Washington University at St. Louis, and he forwarded it to us with a promptitude and courtesy, for which he has our warmest thanks. The specimen is very interesting, and shows clearly that Shumard's figure is a fiction The center appears to be closed, and also the spiracles, not by plates, but by foreign particles such as we have described above. The specimen has the appearance of considerable weathering; none of the outlines are sharp, and the spiracles, which in good specimens are markedly angular, are here almost round. In one of the spiracles only, the arrangement of the particles appears somewhat like

[1] Ann. and Mag. Nat. Hist., Ser. 5, Vol. VIII., 1881, p. 422.

Shumard's figure. At a hasty glance there seem to be six pieces, a central one surrounded by five others; but when examined under a strong magnifier there appear two pieces in the center, and six surrounding them. From this one spiracle, the arrangement of the supposed plates in all the other openings was probably inferred, and the figure made accordingly; for the arrangement of the so-called plates at the four other openings is altogether different, and very irregular. So we find at the anal opening a good sized Gasteropod beside other pieces.

The central opening is covered by a single, comparatively large, elongate body, ovoid in form, which does not actually close the opening, but rests inside of it, beneath the level of the deltoids, slightly touching them. Its position is such that if it represented the summit structure, the food grooves could not have entered the peristome This is also one of those foreign bodies to which we alluded, but its surface is too much worn to say much about it.

Etheridge and Carpenter[1] express some doubt of the correctness of Shumard's description as to the plates covering the spiracles, although they take Hambach to task (pp. 68, 164) for disputing the same description as to the covering of the central opening. They allude, however, to White's discovery of a plated integument over the anal opening in *Orophocrinus stelliformis*, which we are able to confirm. This covering we have found well preserved, not only in *O. stelliformis*, but also in two new species which we described for Vol. VIII. of the Illinois Report now in preparation. In all cases where we found this structure intact, it lies below the level of the deltoid through which the aperture penetrates, and is composed of a large number of small, irregular pieces without any visible opening.

We do not mean to say that the peristome and spiracles were not covered by plates in *P. conoideus*, but we do assert that there was no *such* covering as figured by Shumard. Even in the shape of the spiracles his figure is totally erroneous. He represents them as very regularly pentangular, so as to receive the five supposed plates neatly filling the angles, and as surrounding a central one, one of their sides facing the central opening instead of an angle. The fact is, however, the spiracles are not pentangular but quadrangular, somewhat unequally diamond-shaped with sides slightly curving, the outer angle obtuse, conforming to, and in fact formed by, the slope of the side

[1] Catalogue of the Blastoidea, p. 69

pieces of adjacent ambulacra. The opposite angle toward the centre is acute, and is occupied by a shallow groove which projects in form of a lip toward the center. This form of the opening is remarkably constant in all the specimens of this species, and is characteristic not only of the genus *Pentremites* but also of *Pentremitidea*. That in *Pentremites* a considerable portion of the spiracles was closed by plates of some kind, we think quite probable, but the structure was certainly very different from that described by Shumard.

In 1850, Owen and Shumard[1] discovered a peculiar summit structure in *Pentremites* in a specimen of *P. Godoni*, which they described as a "conical covering of small plates." In 1858 Shumard[2] observed a similar structure in *P. sulcatus*, of which he gave the following account. "In this fossil there rises from the center of the summit a little pyramid with five salient and five retreating angles, the salient angles being directly opposite the extremities of the interradial pieces, while the retreating angles correspond to the center of the pseudo-ambulacral fields. The base of this little pyramid is joined to the superior edges of the pseudo-ambulacral fields so as to completely roof in the buccal and ovarial apertures. It consists of about fifty pieces, arranged in ten series; the first or exterior ones in each series being of a triangular form, the others elongated quadrilateral. Two series of pieces stand over each ovarial aperture, those of one side uniting with their fellows of the opposite side at the salient angles of the pyramid."

No further attention was paid to this structure until 1884, when Hambach[1] proposed to amend Shumard's description by adding that this cone-shaped body "consists of little tubes running parallel with each other and roofing in the summit of the calyx in a conical shape (but not the central opening.) They protude through the same apertures in which the hydrospires terminate; there are about five of these tubes to each aperture, which seem to correspond with the plicas of the hydrospiric sac." He concludes that these tubes extend down into the interior of the calyx, and he takes them "to be the ovarian tubes."

We can confirm Hambach's observation as to the existence of elongate pieces having the external appearance of tubes placed side by side, though we do not concur in his inference of a connection

[1] Journ. Acad. Nat. Sci. Phil., Vol. II. Pt. I, p. 65

[2] Trans. St. Louis Acad. Sci., Vol. I, No. 2, p. 244.

[1] Trans. St. Louis Acad.Sci. 1884,Vol. II, No. 3, p. 541

with his so-called "ovarian tubes," for we have been unable to find any evidence that they pass into the calyx, or that they are longitudinally perforate.

We have been so fortunate as to obtain a large series of specimens exhibiting the structure under consideration in more or less perfection in several species, and we are thereby enabled to present a somewhat fuller description of its nature. We have observed it in *P. sulcatus* in 2 specimens; *P. Godoni* in 2 specimens; *P. pyriformis* in 4 specimens; *P. elegans* in 19 specimens; *P. cervinus* in 3 specimens; and *P. abbreviatus* in 5 specimens, in all conditions of preservation.

It consists in most of them of ten series of pieces—that is five double series, going out in salient angles toward the extremities of the interradial pieces (deltoids)—while in other species the series seem to be composed of more than two rows, and they are not so regularly arranged as in species with only two series. The pieces are located at both sides of, and apparently within, the so called spiracles. They are, as clearly shown in perfect specimens, not plates but elongate, tapering spines, closely packed together, comparatively robust, with a more or less obtusely quadrangular and sometimes, perhaps triangular section, usually curving a little at the tips toward the center. They vary in length, the outer ones being the shortest, those toward the center the longest. We have been unable to discover anything like transverse sutures or longitudinal perforations, and they probably consist of a single solid piece. Although limited to the spiracles, their tips are generally drawn together so as to form a kind of roof over the central opening, while if standing erect they would leave a space in the middle. The spines apparently have no connection whatever with the ambulacra; the side pieces run out and disappear at the spiracles, forming in fact their outer border, and only the food grooves pass in between them to the peristome. Whether the spines cover the spiracles directly, or rest upon independent plates, we cannot say positively, but we are inclined to think that the latter may be the case, and the plates bearing them are set in around the inner margin of the spiracles, so as to cover the greater part of the opening, leaving perhaps a shallow channel passing toward the center over the lip which we have described above.

That the spines, or plates bearing them, extended only over a part of the so-called spiracles, is strongly indicated by the condition of a very interesting specimen of the type of *Pentremites symmetricus* Hall, from Chester, Ill., in which it seems as if the whole pyra-

mid and the covering pieces along the ambulacra, at least near the mouth, were intact and in place when the animal was deposited. It is enveloped in a fine grained silicious mud, fine enough to pass through the smallest opening, and to leave a cast of all cavities. In this specimen there appears over the actinal center a small rounded knob, from which pass out radially, along the upper part of the food grooves, delicate string-like impressions of the inner part of the closed groove. From the inner angles of the spiracles, and passing over the lip-like projections at those angles, are small elevated rounded ridges connecting with the central knob, while the other portion of the spiracle is depressed sufficiently to receive a good sized set of plates. Considering that the parts composed of this fine mud are the counterparts of open spaces as they existed when the specimen was imbedded—all plates and spines being removed by disintegration after it weathered out of the matrix—we may infer that there was at the inner angle of the so-called spiracle a small channel or opening, which probably served as the true spiracle, while the remainder of the aperture—which in this view of the case would represent a mere break in the test—was all covered. At the posterior opening the mud mould occupies a larger space, indicating a larger opening; otherwise we are not able from our specimens to give any special account of the anal opening; neither can we observe any special difference in the arrangement of the spines about the posterior opening from that of the others.

The shape and construction of the spiracles in *Pentremitidea* is very similar to that of *Pentremites*, and we should not be surprised to find its summit surmounted by a similar structure. We fully agree with Etheridge and Carpenter in placing these two genera in the same family, but we are not so sure as to *Mesoblastus*, which we think might be placed more appropriately with *Schizoblastus* and *Cryptoblastus*.

The condition of the central opening in *Pentremites* cannot be accurately determined from any of our specimens, but we have distinctly seen that it is covered by several plates, independent of the roofing by spines.

The food grooves, which pass out between the spines at the retreating angles of the cone, are vaulted over by two rows of covering pieces which are alternately arranged. These pieces close the central groove of the ambulacrum, whence they branch off so as to cover also the lateral grooves toward the pinnules. The plates cov-

ering the side grooves, which are arranged as regularly as those of the main grooves, have been traced by us as far as the fifth side pieces, but may have extended farther down. In spite of their small size, the plates are very distinct in our specimens, those of the upper row resting closely against the spines.

Messrs. Etheridge and Carpenter have given two figures showing the summit of *Pentremites* in two different conditions of preservation, both of them from specimens belonging to us. The first figure of *P. sulcatus*, (Pl. I, fig. 8.), gives a somewhat incorrect impression of the external appearance of the pyramid, owing to the fact that the spines composing it have been irregularly broken off a little way above their bases, so that what there appear as plates are really the cross sections of the spines. The fracture, however, is not regular, nor at right angles to the long dimension of the spines, so that the figure does not correctly represent either the real form of the cross sections, or their relative positions. We may observe also that the figure does not give the central portions. By applying a little aniline coloring matter we have been able to see the sutures indicating the broken ends of spines, but the fracture is so irregular that the arrangement cannot be distinguished. In their other figure on Pl, V, fig, 28., which gives a good idea of the form and character of the spines composing the pyramid, some of the pinnules are preserved overlapping the spines and resting upon them, showing in marked contrast the difference between the two structures.

After quoting and commenting upon Shumard's and Hambach's descriptions of the pyramid in *P. sulcatus*, and having before them the original specimens represented in the above mentioned figures, Etheridge and Carpenter[1] give their intrepretation of the facts as follows:

"Mr. Wachsmuth has sent us a fine specimen, which may perhaps throw some light on this difficult question, (Pl, I, fig. 8.) The peristome and spiracles are almost completely covered by what seems to be the base of the little pyramid described by Shumard." The upper part of the pyramid described by Shumard and Hambach "seems to us to be constructed by the proximal pinnules, as in the specimen represented on Pl. V, fig. 28. In Mr. Wachsmuth's example of *P. sulcatus*, however, these proximal pinnules are not preserved, and the angles of the pyramid extend outwards towards the pointed ends of the visible parts of the deltoids. At two of these angles there seem to be indications of a double series of plates above

[1] Catalogue of the Blastoidea, p, 70.

the spiracles." They "have little doubt that this is fundamentally the same structure as was seen by both Shumard and Hambach." According to the latter author, there are "about five" of the supposed tubes to each spiracle; while Shumard says that two series of pieces stand over each opening, and except in the anal interradius this seems to be the condition of Mr. Wachsmuth's specimen also. But we do not think that the pieces have the tubular nature which Hambach assigns to them; for we doubt whether they are more than the proximal pinnules grouped around the peristome as shown in our Pl. V, fig. 28."

In their explanation of the plate, this figure is said to be a "radial view of a decorticated specimen, with the pinnules rising above into a kind of dome." No allusion is made to any difference between the bundles of jointed pinnules which fall over the summit from each side, and the set of apparently rigid, erect and jointless appendages which are seen between them. Nor do the authors anywhere in the text appear to recognize any such difference, although it is to us quite apparent, both in the figure and in the specimen which was before them.

After arriving at this as a probable interpretation of the structures observed by Shumard and Hambach and figured by themselves, and dissenting from Hambach's supposition, that the so-called tubes pass down into the interior of the calyx, they arrive at this further conclusion: "We are much more inclined to think that we have here to deal with an extension of the smaller system of summit plates, which occur in other Blastoids. In *Granatocrinus* and *Elaeacrinus* only the peristome appears to be covered, (Pl. VII, figs, 4. 11. 13; Pl. XVIII, fig. 16), except perhaps for the anal aperture in *G. Norwoodi;* while *Orophocrinus* and *Stephanocrinus* have a group of plates around the anal aperture (Pl. XIX, fig. 9). In *Pentremites conoideus* the other four spiracles are perhaps also closed by plates; and except in the larger size and abundance of the plates it is no great advance from this condition to that which we have seen in *Pentremites sulcatus* (Pl. I, fig. 8.), but we await further information."

The supposed closure of the spiracles by plates in *Pentremites conoideus* proves to be unsupported by the facts. A correct understanding of the nature of the pyramid surmounting the vault in *Pentremites sulcatus* and allied species will, we think, fully demonstrate that this structure, which probably existed in all *Pentremites*, is a totally different thing from the covering of the anus in *Oropho-*

crinus, *Stephanocrinus* or *Granatocrinus*. In the three latter types, the so-called covering does not extend to the spiracles, but consists apparently of a sort of moveable plates, by means of which in various ways the anal aperture could temporarily be opened or closed as its functions required.

The views expressed by Etheridge and Carpenter that these spine-like pieces forming the pyramid are nothing but the proximal pinnules, cannot, in our opinion, be sustained by any of the evidence. There are very serious objections to it:—

1. They consist of a single piece throughout their entire length, whereas pinnules are composed of small joints. The specimens all show this distinction well, and it may be clearly seen in Etheridge and Carpenter's Pl. V, fig. 28.
2. They have no ventral groove, and taper to a point; while pinnules are nearly uniform throughout, and especially do not taper perceptibly from their bases.
3. They are more robust than the pinnules in the same specimen, and shorter—the pinnules passing beyond their tips.
4. The best preserved specimens show that the pinnule sockets end at the spiracles where the two rows of adjoining ambulacra come together in a point. The spines, however, seem to begin where the pinnules end, and extend from there inward, the clusters widening toward the center so as to form the retreating angles at the base of the pyramid.
5. The spines are interradial and interambulacral, and as such may belong to an interambulacral system, which perhaps is unrepresented in other groups of the Blastoids, but certainly form no part of the ambulacral system.

Whatever the spines in *Pentremites* may be, or represent morphologically, we think it will have to be conceded that they are not "proximal pinnules," and not comparable to the plates covering the anus of *Orophocrinus*, *Stephanocrinus* or *Granatocrinus*.

On page 73, Messrs. Etheridge and Carpenter attempt to establish a series of variations in the summit plates of the Blastoids, "similar to that which can be traced among the Palaeocrinoids. The simplest form of summit which occurs in any Blastoid is that presented by *Stephanocrinus*. The peristome is completely closed by the five triangular plates of the so-called proboscis." They state that Hall, in his diagram of the structure of the summit in *Elaeacrinus elegans*[1]

[1] 15th. Rep. N. Y. St. Cab. Nat. Hist. 1862, p. 153.

figures only five plates of equal size; and they add:—"These five plates of *Stephanocrinus* and *Elaeacrinus* have exactly the same relation to the peristome and ambulacra as the oral plates of a Neocrinoid, and we do not see how their mutual homology can well be disputed." On page 74 they continue: "The difference between *Elaeacrinus elegans* or *Stephanocrinus* and *E. Verneuili*, as described by Roemer, is very much the same as that between *Culicocrinus* and the simplest form of *Platycrinus*. *Stephanocrinus*, like *Culicocrinus*, has but five plates in the vault; while in *E. Verneuili* there are at least seven, viz.: one orocentral, four proximals of equal size, and two smaller ones on the anal side." They allude to White's description of the summit of *Orophocrinus stelliformis* as consisting of five small plates etc., which they say is "just as in *Stephanocrinus* and in *Elaeacrinus elegans*"—though they add that their arrangement does not seem to be very constant. On page 75, they speak of the summit of *Granatocrinus Norwoodi* varying in a similar manner, and of a "somewhat less regular arrangement" in *Schizoblastus Sayi*.

It thus appears that their conclusion that the plates of the vault in Blastoids "rarely exhibit any definite arrangement,"(p. 118) and that there is a series of variations in the summit plates of the Blastoids similar to, and to some extent parallel with, those which they assume to exist in Palaeocrinoids, is based on the presence of five plates in *Stephanocrinus*; the assumption of five plates in *Elaeacrinus elegans* and *Orophocrinus stelliformis*, in contrast with seven plates in *E. Verneuili*; and variability in the number and arrangement of plates in the summit of *Granatocrinus Norwoodi* and *Schizoblastus Sayi*.

It is somewhat unfortunate for the validity of this speculation that *Stephanocrinus* cuts so important a figure in it, as it has since been discovered to be not a Blastoid at all, but a brachiate Crinoid; a fact,[1] it is proper to say, which is noticed by the authors in their preface. This genus, therefore, must be eliminated from among the premises on which the argument is built, and the "simplest form" must be looked for elsewhere. Let us see how far the others will stand the test of examination.

Elaeacrinus elegans was described by Hall[2] under *Nucleocrinus*, and in his specific description,—and not simply in his generic diag-

[1] Revision of the Palaeocrinoidea, Pt. III, p. 282, etc.

[2] 15th, Rep. N. Y. St. Cab. Nat. Hist. 1862 .p. 147.

nosis, as stated by Etheridge and Carpenter—he says the summit is "occupied by *five or more* small plates." In the diagram, on page 153 of the work cited, the summit is represented as divided into five equal and similar areas by the meeting of lines prolonged from the middle of the ambulacra. It is apparent that no attempt was made to give the exact form or number of those plates. They are not lettered as the other plates are, and no mention is made of them in the explanation of the figure; nor does Hall anywhere seem to have attached sufficient importance to the summit plates to give a description of their shape, position, arrangement, or relative size.

In order to satisfy ourselves as to what the real facts are, we applied to Prof. R. P. Whitfield for the loan of the type specimen of *E. elegans* showing the summit plates, now in the collection of the American Museum of Natural History in New York City. Prof. Whitfield, with his usual kindness, for which we are under renewed obligations to him, promptly sent us the original specimen from which fig. 14, of Pl. I, as well as the diagram on page 153 of the 15th Report was made; and in his letter transmitting it he says: "I fear you will not see clearly the arrangement of the plates. There are *more* than five plates—probably eight". The italics are his. By applying water, colored with aniline, and then moderately brushing the surface so as to remove the coloring matter except from the sutures, we were enabled to distinguish the presence of a central piece surrounded by seven others,—four large and uniform, and three smaller ones at the posterior side (fig. 11.) This gives a summit structure substantially the same as that of *Elaeacrinus Verneuili*, (see Etheridge and Carpenter, Blast. Cat. p. 215).

We also applied to Dr. Barris for the loan of his specimens of *Elaeacrinus obovatus*, and these, together with our own, gave us eight specimens of this species, all having the summit in *situ*. The four large proximals are readily recognized in most of them, but only a single specimen enabled us to distinguish all the plates as they are shown in fig. 12. In four others, the suture line between the central plate and the small anal piece is seen as plainly as we could wish, but there is no trace of a suture toward the smaller proximals (fig. 13); while in the three remaining ones, including the largest specimen, it appears as if the summit consisted of only five plates (fig. 14.) There is, however, no variation in the form and general outline ot the summit in any of these specimens. The summit in all of them rests posteriorly between the two halves of the

compound deltoid and against the intermediate large anal plate, and in all of them the lower margin is perforated and occupied by one half of the anal aperture, thus showing that in this species also the summit consists primitively of eight pieces, of which the suture lines became partially obliterated.

In the type specimen of *Elaeacrinus meloniformis*, which Dr. Barris was kind enough to send us also, the arrangement of the summit plates is the same as in *E. obovatus*, and we clearly distinguished the small anal plate.

It thus appears that in the known species of *Elaeacrinus* the summit plates consist of a central plate surrounded by six or more proximals, and that in no case do they consist of five primitive plates; so that the "simplest form of summit"—five plates only—has not been found in *Elaeacrinus*. The assumed parallelism of differences between *E. elegans and E. Verneuili* among the Blastoids, and *Culicocrinus* and the simplest form of *Platycrinus* among the Crinoids, encounters a very serious interruption in consequence—unless, indeed, it should turn out that there is a parallelism in these cases of an altogether different character from that contemplated by the English authors.

The summit of *Orophocrinus stelliformis* was stated by White[1] to consist of "five small plates arranged like a five-pointed star, with the points touching each of the upper ends of the interradial plates." We do not doubt that Dr. White thought to observe such arrangement, but we think it very probable that the condition of his specimen was such that he overlooked the central plate, which may easily happen, as the sutures are often difficult to observe. In a large number of specimens we have never found a single one with the summit composed of five plates only, or with a central plate surrounded by five proximals. We found, however, that in specimens of this species, as well in *Granatocrinus Norwoodi* and *Schizoblastus Sayi*, when the covering plates are in place, they often partly overlap the summit plates, and in such cases the arrangement of the latter cannot be distinctly observed. When the covering pieces are absent, and the summit plates alone are intact, as in several of our specimens, the arrangement is quite regular. We have made a careful examination of a large series of specimens, not only of *O. stelliformis* but also of our new species *O. fusiformis* and *O. conicus*, in which the summit plates are more frequently preserved. In all of them there is a

[1] Boston Journ. Nat. Hist. 1863, Vol. VIII, No. 4, p. 487.

central plate, surrounded by others, either six or seven. Even the original of Etheridge and Carpenter's figures 11 and 12 on Pl. XV, in our collection, upon the application of coloring matter to bring out the sutures, proves to have a quite regular arrangement of the summit plates, which the artist who drew the figures failed to detect. There are certainly not "five small plates," but a central plate surrounded by six proximals.

According to our observation, therefore, of the best preserved material known, the summit of *O. stelliformis* does not represent the "simplest form,"—"just as in *Stephanocrinus*."

There remains only to consider *Granatocrinus Norwoodi* and *Schizoblastus Sayi*, as to both of which we remark that there is often presented much apparent irregularity and variability in the arrangement of their summit plates. But we find that this is due to the encroachment of the covering plates, which sometimes largely overlap them, as is well shown by Ether. Carpenter's Pl. VII, figs. 11 and 13. But in natural internal casts, in which we have the impressions of the inner surface of the plates, they appear larger and much more regularly arranged. Among a large number of specimens we have failed to find a single example of a summit closed by only five plates; while in a large proportion of them we distinguished clearly a central plate surrounded by six or more proximals. Whatever variations, however, of form and arrangement of summit plates may be found to exist in these two species, we feel warranted in asserting that the "simplest form" is not one of them.

On page 71, (Catal. of the Blastoidea), Messrs. Etheridge and Carpenter say that "in 1877, Wachsmuth pointed out that a definite arrangement of plates is more or less traceable in the vault of many Palaeocrinoids. There is a single central plate, with five or, more frequently, six others disposed interradially round it." It would naturally be inferred from this remark and the context, not only that *five* proximals around a central plate is one recognized condition in the vault of many Palaeocrinoids, but also that Wachsmuth had so expressed himself:—whereas the fact is *he said nothing of the kind* in the paper cited, but on the contrary spoke only of "7 apical plates"—a central, four large, and two small ones; and this number, or a greater, has been insisted on by us as being the almost universal rule.

In seeking for a transition or variation in the summit plates of Palaeocrinoids, comparable to that which they assume to exist

among the Blastoids, they take the young stage of *Allagecrinus* (p. 72), as presenting "the simplest form of vault," i. e. five plates without any central; and *Haplocrinus* next, with a central piece and five proximals, "neither *Allagecrinus* nor *Haplocrinus* having any calyx interradials." *Culicocrinus* is cited as having five large summit plates resting on the calyx interradials, and without any central piece. Then come *Platycrinus* and the Actinocrinidae as exhibiting varying degrees of complexity, but having a central plate, which they call an "oro-central," surrounded by proximals. In this case also, they base a large part of their argument upon premises which are by no means universally recognized, or are free from dispute. We consider it far from being an established fact, that either *Allagecrinus* or *Haplocrinus*—*Culicocrinus* will be considered later on—are without calyx interradials.

As we have before stated, Etheridge and Carpenter maintain, and it has been steadily insisted on by Dr. Carpenter since 1879, that the proximal plates, surrounding the central plate in Palaeocrinoids, their so-called "orocentral," represent the five orals of Neocrinoidea. This involves the assumption of a homology between a set of plates covering the actinal center, which are five in all stages of the Neocrinoids in which they exist, and a set of plates which, when present in Palaeocrinoids consist of six or more plates, which do not cover the actinal center, but which enclose another structure that does. It is in order to get rid of some of these difficulties that the authors attach so great importance to the cases of *Allagecrinus*, *Haplocrinus*, *Culicocrinus*, *Coccocrinus*, and *Stephanocrinus*, in which they undertake to point out a series of five plates at the ventral side, as the representatives of six or more proximals in Palaeocrinoids generally, and which at the same time might be successfully homologized with the orals of the Neocrinoids. In this connection they remark on page 73:—

"Since the preceding paragraph was in type, we have received the latest publication of Messrs. Wachsmuth and Springer, according to whom the five plates which form the ventral pyramid of *Stephanocrinus* are 'calyx interradials,' and cannot therefore be homologous with the orals of a Neocrinoid. In making this comparison Messrs. Wachsmuth and Springer seem to have altogether overlooked the fact that *Stephanocrinus* has well developed calyx interradials, namely, the deltoids. * * * The American authors regard the deltoid pieces of the Blastoidea, and by implication

therefore those of *Stephanocrinus*, as homologous with the large calyx interradials of the Cyathocrinidae, a view in which we entirely concur, as we have explained on p. 10. But in applying this name to the five plates which form the ventral pyramid and cover the mouth of *Stephanocrinus*, and also of *Haplocrinus* and *Allagecrinus*, as they do in their latest publication, they seem to us to be going very much too far. We regard the five summit plates of all three genera as truly homologous with the orals of the Pentacrinoid larva. They cover the mouth and the origin of the ambulacra, just as the orals do in the Neocrinoid; and this relation is not characteristic of the calyx interradials in any Pelmatozoon whatever. It is only in the Cyathocrinidae and in the Blastoids that these plates have any close relation to the mouth at all. But they do not cover it and shut it off completely from the exterior as the summit plates of *Stephanocrinus* and *Allagecrinus* do."

We have been more than once charged by Dr. Carpenter with inaccurate statements as to his views, and in some cases with reason as we have admitted; but we do not believe we have ever been chargeable with anything so completely unfounded as the foregoing criticism. It is based entirely upon the single remark of ours on page 46 (Revision Palaeocr. Pt. III), that "the ventral pyramid in *Haplocrinus* and *Coccocrinus* is composed of interradials and not of orals, and the same may be said of *Stephanocrinus*."* This was written under the supposition, then entertained by all Palaeontologists, perhaps with the exception only of Etheridge and Carpenter, whose interpretation will be quoted presently, that *Stephanocrinus* was constructed of only three ranges of plates, and we considered the third row, constituting the whole portion from the coronal processes inward, to be interradial plates. Messrs. Etheridge and Carpenter[1] in 1883, interpreted all plates, in common with the deltoids of the Blastoids generally, and the interradials of the Cyathocrinidae, as orals,—a view which they have since abandoned. In the same paper—p. 239—they mention five plates in the summit, composing, according to Hall, a central "proboscis," and say that they have "only seen this proboscis in one specimen," and regard it as "a vault of a few pieces covering in the peristome." This shows clearly that they did not themselves at that time consider these

*We even did not use the term "*calyx* interradials" in that quotation, we simply spoke of the "*interradials*."

[1] Ann. and Mag. Nat. Hist. Apr. 1883, pp. 225 to 246.

"proboscis" plates as representing the orals, and, so far as we know, they never afterwards, until the appearance of the Blastoid Catalogue, gave any other interpretation of the inner ring of plates. If they had regarded them as orals, it would have suggested the presence of two rings of orals, the one within the other.

Subsequently we found reason to distinguish two rings above the radials—the so-called orals or deltoids of Etheridge and Carpenter and a series of summit plates—the so-called "proboscis"—from a specimen of *S. gemmiformis;* and we communicated this fact to Dr. Carpenter as early as Dec. 17th 1885 with a diagram explaining it, stating that, although summit plates in our specimen were not preserved, such plates were probably represented in the species. We also informed him that it was the third ring or deltoids, and not the summit plates, which we took to be the homologues of the interradials in *Haplocrinus;* and that the hypothetical plates closing the summit we took to be represented in *Haplocrinus* by the central plate. At the same time we applied to Prof. Whitfield for specimens to ascertain the summit structure in *S. angulatus.* From these specimens we at once found beyond all doubt that the plates of the third row in *S. angulatus,* as well as in *S. gemmiformis,* do not extend to the oral center, but are followed by five other plates—the so-called "proboscis"—covering the mouth (fig. 3). Upon making this discovery we promptly declared the latter to be the orals, and advised Dr. Carpenter accordingly on January 9th 1886. *

Our statement, therefore, that the "ventral pyramid" in *Stephanocrinus* is composed of interradials, was made with reference to plates which we then supposed to be a single element, extending to, but not covering the oral center, and which Etheridge and Carpenter had previously announced to be orals followed by vault pieces, but now consider to be deltoids followed by orals. When the authors assert that we applied the name "calyx interradials" to the "plates which form the ventral pyramid *and cover the mouth of Stephanocrinus* and also of *Haplocrinus,*" we cannot help thinking that they are "going very much too far." A similar erroneous statement was made by Dr. Carpenter in March 1886 [1] and it has been a matter of consid-

*It is due to Dr. Carpenter to state here that he had privately communicated to us, after Sect. I of Pt. III of our Revision was in print, that he regarded the inner ring of *Stephanocrinus* as orals, and this led to our correspondence upon the subject.

[1]Ann. and Mag. Nat. Hist., March, 1886, p. 282

erable surprise to us that in both these publications we should be held up to criticism for a statement which we did not make in any such form as their language would imply, and that the authors should indulge in a general adverse comment upon our incidental remark on *Stephanocrinus*, without the slightest intimation of the very important additions to our former views consequent upon new discoveries, which would have made our meaning entirely clear. These were published in Part III, Revision of the Palaeocrinoidea, pp. 282–290.

To represent us as arguing that the plates which we recognize as calyx interradials "cover the actinal center," or "cover the mouth and the origin of the ambulacra," seems to us very much like setting up a man of straw for the pleasure of knocking him down. For our whole argument in favor of a homology of the orals of the Neocrinoid with the central plate in Palaeocrinoids, has been expressly put upon the ground that the latter plate covers the actinal center; and one of the strongest objections we have constantly urged against such a homology with the proximals, has been that they do *not* (Rev. Pal. Pt. III, p. 53). Etheridge and Carpenter add in continuing their criticism above noticed: "There is not a single Crinoid known in which plates which are universally recognized to be calyx interradials cover in the actinal center." Of course not; and we do not know of anybody who says they do. But on the other hand it is equally true that there is not a single Palaeocrinoid known in which the plates that are universally recognized as orals cover the whole ventral surface; and upon this ground we might well contend that if the plates which Etheridge and Carpenter consider to be orals are really such, then *Allagecrinus* and *Haplocrinus* are Neocrinoids, in which from the larva to the adult, as a rule the whole ventral surface is covered by actinal structures. Their statement above cited, as to the homology of plates which "cover the mouth and the origin of the ambulacra, just as the orals do in Neocrinoids," might be profitably applied to the case of *Caryocrinus*, as shown by a number of excellent internal casts recently obtained from Racine, Wisconsin. *Caryocrinus* has a large central piece, and this is surrounded usually by eight plates, which are arranged in a totally different manner from the so-called proximals of the Palaeocrinoidea. Three of them are radial, the others interradial, (figs. 6-7). The interradial pieces alternate with the radial ones, one to each side, except at the anal interradius where three smaller pieces

take the place of the single one at the two other sides. Like most of the Cystidea, *Caryocrinus* has no true radials, although it has well developed arms. The rays start from underneath the central plate in a similar manner as they do in allied genera from underneath their quinque-partite oral pyramid; but the ambulacra, instead of entering the surface at once, as in other groups, here remain subtegminal until they enter the arms, following the medium line of three radial plates, and branch (fig. 7) underneath them twice to their respective arm openings. In this case, the central piece which "covers the mouth and the origin of the ambulacra" must surely represent the orals if any plate does, but not the plates which surround it and cover neither the mouth nor the origin of the ambulacra. We should like to know by what process Messrs. Etheridge and Carpenter will demonstrate the oral nature of either the radial or interradial plates in this form.

We have already alluded to the great importance toward the establishment of Etheridge and Carpenter's oral theory, of their proving the existence both in Crinoids and Blastoids of a summit composed either of five plates only, or of a central plate surrounded by five. This is why the series of parallel transitions or variations in the summit plates of the two groups is so strenuously urged in the Blastoid Catalogue. But it seems to us that the authors have altogether failed to point out a single instance in which five primary plates cover the peristome among the Blastoids. The cases which have been relied upon to prove such a condition, must be attributed to incorrect observation or the want of sufficiently good material. That occasionally in certain species of *Elaeacrinus* the central piece is more or less coalesced with the proximals of the azygous side, and these with one another so as to obscure the suture lines, as we have shown in our illustrations figs. 12 to 14, cannot alter the case in the least, as they are plainly visible in others, and without any change in the general arrangement of the summit. Nor does it seem to us that the authors have been any more successful in showing how among Palaeocrinoids the five large plates in *Haplocrinus*, covering the whole ventral surface except the oral pole, could have been transformed in other groups of the Palaeocrinoidea into six plates covering only a small space around the peristome. These five plates in *Haplocrinus* occupy the same position, as the primary calyx interradials of other groups, and especially resemble those of *Cyathocrinus* and *Stephanocrinus*. (Compare figs. 2 to 5).

It may not be out of place to mention in this connection that in *Haplocrinus* there appear radially between the five large ventral plates, upon their lateral edges, five conspicuous grooves (figs. 4 and 5), which were regarded by Prof. Zittel (Handb. d. Palaeont, I, p. 347) as ambulacral furrows. Similar grooves exist in *Cyathocrinus*, *Stephanocrinus* and other Inadunata along their interradials, and in all of them the grooves are occupied by the ambulacra. The similarity between these grooves, no doubt, induced Prof. Zittel to give to those of *Haplocrinus* the same interpretation. Unfortunately, however, the central plate of *Haplocrinus*, as plainly seen in our specimens, does not occupy exactly the same level as the upper angles of the five large plates, but lies (Fig. 4) below their level and between them, just as if it were being pushed from within outward so as to separate the five plates at the central space. The peculiar position of the central plate demonstrates, we think beyond any doubt, that the ambulacra of *Haplocrinus* could not have been exposed upon this groove, but at the same time it appears to us that these grooves, which occupy relatively the same position toward surrounding plates and the peristome, and are formed in a similar manner, must represent morphologically the same grooves, which are occupied in higher developed types of this group by the ambulacra (fig. 3). Supposing that *Haplocrinus*, as we find it in the fossil state, were but an embryonic stage of the species—the genus has been regarded a permanent larval form of the group—we think we might safely assert from the phylogeny of the Palaeocrinoidea generally, that in the growing animal the central plate was pushed outward so as to appear at a level with the five interradials; that subsequently by the growth of the dorsal cup, and the widening of the peristomial area, proximals appeared around the central piece; and that at last the ambulacra were pushed out to the surface to occupy the radial grooves, which were present already in the young *Haplocrinus*. The different stages to which we here have alluded are well represented in palaeontological times throughout the Inadunata, and not only among them, but also among the Camarata under very similar conditions.

The Camarata or Coadunata differ from the Inadunata in having their proximal arm joints incorporated into the calyx by the upward growth of interradials; while in the Inadunata the arms remain free from the first radial, and they have but one interradial which is disposed ventrally. That all Camarata passed temporarily

in early life through the Inadunata stage, seems to us beyond dispute, and we think we may assert that they were for a time in a similar condition to *Haplocrinus*, with one interradial plate disposed ventrally. Limiting our observations among the Camarata to the Platycrinidae, we find, so far as we know, their simplest forms represented by the two early genera *Culicocrinus* and *Coccocrinus*, which both have two rows of plates interradially disposed, the one resting within the circlet of the other. In *Culicocrinus*,* if Miller's figure is correct, the first row of these plates consists of five rather large pieces, one to each interradius, which connect laterally with the primary and secondary arm plates, so as to make them radials and integral parts of the calyx. Those of the second row which are triangular meet laterally and close the center, apparently without any additional plates.

Of *Coccocrinus* two species are known. *Coccocrinus bacca* has three interradials in the first row, which have a strictly ventral position, *C. rosaceus* apparently but one, which is more erect. In both species the plates extend to the height of the third primary radials, and probably higher. The inner row of plates is only known in *C. rosaceus*, and these, like those of *Culicocrinus*, are subtriangular, but, unlike them, do not connect laterally with one another, nor do they meet in the center. There is a lateral slit between them all the way to the arm openings, and at the center an open space, which in the fossil is not filled by any further structures. In *C. bacca*, as stated, the inner plates have not been preserved, but we scarcely doubt that similar plates were present, for we find in a radial direction between the outer plates of the first row, very conspicuous slits, which correspond to those of *C. rosaceus*.

The outer plates, in the two genera, were regarded by Carpenter as calyx interradials, the inner ones as orals, and these he took to be the homologues of the five large ventral plates of *Haplocrinus*, and of the proximals in other groups.

We admit that *Coccocrinus* and *Culicocrinus* probably are morphologically in a similar condition, and represent early stages in the phylogeny of the Palaeocrinoidea like *Allagecrinus* and *Haplocrinus*,

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*Through the kindness of Prof F. Roemer, we received a most excellent gutta percha cast of a *Culicocrinus* with arms, from a mould in the Mineralogical Museum of Breslau, but not showing the ventral covering. Miller's original figures of the ventral covering, Lethea Geognostica of 1855, Taf. VIII, fig. 1 and 2, we are informed are much restored, and the arrangement of the plates, as there given, not altogether reliable.

but we doubt if this is the case in the sense Dr. Carpenter suggests. The two former are Camarata, and as such should be provided with more than one row of interradials, which they would not possess if the inner plates were orals.

Based upon palaeontological evidence, we think, we may reasonably suggest that in the developmental history of *Culicocrinus*, at the close of the Inadunata stage, the first row of interradials opened out to connect the proximal arm plate with the calyx, and that a second ring formed to take the place and functions of the first, closed the center.

Coccocrinus forms a connecting link between *Culicocrinus* and *Platycrinus*. Probably it has one or more summit plates, and the ambulacra disposed between the interradials.

In *Platycrinus*, the inner interradials, which in *Coccocrinus* are yet placed at a level with the dorsal cup, are considerably more raised. In consequence thereof we find in this genus much larger spaces between the interradials, centrally as well as laterally, and hence better developed summit plates and larger and heavier covering pieces. Of the summit pieces probably the central plate appeared at first—this is indicated by the phylogeny of the group—and the proximals appeared later, filling the vacancies, which gradually had formed around the central plate.

In this sketch we have not added anything that is not well sustained by the phylogeny of this group, or is not in accordance with the developmental history of the Palaeocrinoidea generally. Throughout this order, when summit plates are exposed at all, they occupy a comparatively small space around the peristome, and this space increases in width in palaeontological times. In all Palaeocrinoids, so far as known, and we may add, in all Blastoids, the peristomial area is formed by the calyx interradials, whether these consist of one piece, as in the case of the Inadunata and Blastoidea, or of two, three, or a dozen pieces, as in the Camarata; and the summit plates, whether composed of a central plate only, or of proximals also, rest against the upper margin of the interradials. In all Neocrinoidea, however, from the larva to the adult, the whole ventral surface is covered by actinal structures, the small interradials which were observed by Sir Wyville Thomson, disappear again soon after their development, and never attain any such prominence in the composition of the calyx as in the earlier Crinoids. This character, which distinguishes the two groups so readily, would meet with most

serious exceptions if the ventral plates in *Allagecrinus*, *Haplocrinus*, *Culicocrinus* and *Coccocrinus*, as asserted by Carpenter, represented the orals. We think it was the superficial resemblance in the form and position of these plates with the orals of certain Neocrinoidea that led Carpenter to regard them as orals. He probably overlooked the fact that the plates agree equally well on those points with the interradials of the Cyathocrinidae, and that as interradials the above genera would not be exceptional types, but comply with the morphological conditions of all their contemporaries.

We have shown that *Culicocrinus* and *Coccocrinus*, as members of the Camarata, should have more than one interradial plate, and it is not very likely that the secondary one, exceptionally in those genera, would be substituted by a ring of oral plates. But there is another serious difficulty. The slits in *C. bacca* extend out to the first row of ventral plates as well as to the second, and this suggests that, if *Coccocrinus* were "like the recent genus *Holopus*" to be "permanently in the condition of a crinoid larva, in which the orals have not yet moved away from the radials, though separated from one another,"* then both rows of plates were orals, one ring within the other. Where among the numerous families of the Palaeocrinoidea do we find an instance in which the plates constituting either the oral pyramid or the proximals, are separated in that manner? Nowhere; but if there was such a case, we certainly would find it in the highest developed forms and not in the larval ones. Again, where do we meet among Palaeocrinoids with an open peristome? In the earliest stages of the Neocrinoid larva, the orals are closed, and in the earlier forms of the Camarata, such as *Reteocrinus*, *Glyptocrinus*, etc., the peristome is closed either by the upward growth of the calyx, or by a small central piece, there being no proximals, and hence, according to Carpenter's interpretation of these plates, no orals. Those genera appear to us to be in a similar condition to *Allagecrinus* and *Haplocrinus* among the Inadunata, and *Culicocrinus* and *Coccocrinus* among the Camarata, but not in the condition of the Neocrinoidea at all. However, we can readily understand why Carpenter holds so tenaciously to these plates as orals, for it is principally upon these plates that he bases his further theory, that in the higher Palaeocrinoidea the orals are represented by the proximals; indeed they are his "simplest forms" which he failed to find among Blastoids. In the Challenger Report on p. 170, he says: "The proximal dome

* Chall. Report, p. 163.

plates rest directly against the calyx interradials, that on the posterior side being represented by two small plates with the anus between them" while there is a more or less tubercular ring of radial dome plates outside them. These proximal dome plates thus correspond exactly to the orals of *Symbathocrinus* and *Haplocrinus*, covering in the peristome and resting against the calyx plates, which in the *Platycrinus* are the interradials, and not the upper edges of the radials, as in the simpler forms"; and on p. 171: "I cannot therefore see what other view can be taken of the proximal dome plates which immediately surround the orocentral, than to regard them as orals, *i. e.*, as the actinal representatives of the basals, like the corresponding plates in *Symbathocrinus*. *If this be admitted*, it follows that the proximal dome plates of all Platycrinidae, Actinocrinidae and Rhodocrinidae are also homologous with the orals of Neocrinoids."

These conclusions *perhaps* might be well enough, IF such a thing as an orocentral had been established; but unfortunately this is not the case. Neither are the plates in *Symbathocrinus* of which he speaks as "the orals," in our opinion, anything but proximals, and hence all conclusions based thereon, to say the least of it, are inexpedient and rash. It is somewhat surprising that Dr. Carpenter, although his whole theory is actually based upon his hypothetical "orocentral," gives such a meagre account of it. In the Challenger Report, in introducing it on p. 158, he devotes to it only a few lines. Referring to the small central plate of *Haplocrinus*, he says: "This plate is one of considerable importance in its morphological relations. In accordance with the views which I have expressed elsewhere, I believe it to be the representative on the actinal side, or left larval antimer, of the dorsocentral plate which is developed in the center of the right antimer or abactinal side of Urchins, Stellerids, and Crinoids." And on pp. 159 and 170, in pointing out its relations to the proximals, he calls the plate the orocentral, and speaks of it as a single plate. That is all Dr. Carpenter had to say about it, and probably all that could be said, for such a plate has been heretofore unknown in Echinoderm morphology.

We do not deny that the so called dorsocentral of Urchins and Stellerids is represented in the Comatula larva by the terminal plate of the stem, but we see no good reason to postulate from this a similar plate in the oral center. There are at the abactinal side frequently also underbasals, which on the same principle should be represented orally, but nothing is known of them. Why should

the dorsocentral be represented at the actinal side when there is no actinal stem, in this or any other group of the Echinoderms? The dorsocentral in the Echinozoa represents in a wider sense the whole column in its simplest form, although in a narrower sense it is the homologue of the first part of the stem that makes its appearance in the embryo. If there was such a thing as an orocentral in fossil Crinoids, Blastoids and Cystids, it seems to us, it certainly would be represented in the early larva of the living types before the parting of the orals, and in the closed oral pyramid of the Cystids and *Stephanocrinus*; but unfortunately for Carpenter's theory we meet with no trace of it in either one of those forms. The plate which he regards as orocentral, occupies the place of the five orals in other groups, and in a similar manner as these, covers the peristome and the origin of the ambulacra. This is conclusively shown by comparing the case of *Caryocrinus* in which the ambulacra start from beneath the central plate and branch twice underneath the surrounding plates, with the case of *Sphaeronites* (fig. 1) and *Stephanocrinus* (fig. 3), in which the ambulacra start from beneath a penta-partite oral pyramid. Does this indicate that the five plates constituting the latter, are the representatives of the proximals? We doubt it, for the structural resemblance is with the central piece. We think the distribution and arrangement of the surrounding plates in *Caryocrinus* proves conclusively that these cannot be orals, for the most ingenious speculator would be unable to reconstruct five primitive plates from such an assemblage of pieces as we find in *Caryocrinus* and in Von Koenen's new genus *Juglandocrinus**. What those plates may be, whether actinal or abactinal structures, we will not pretend to decide, but we do undertake to say that they are not orals, otherwise the rule that there are always five primitive orals meets with a very serious exception.

Somewhat more favorable perhaps to Carpenter's views is the arrangement of the proximals in the Palaeocrinoidea and Blastoidea, in which the plates surrounding the central piece are unquestionably actinal structures, and there is a possibility of reconstructing from the six, seven, or more pieces, five primitive plates. We also admit that in all cases where those plates come in direct contact with the anal structures, their arrangement might possibly have been disturbed thereby, but this explanation is not applicable to forms like *Megistocrinus*, *Dorycrinus* and many others, in which the anus is lateral or moved away from the center to the arm regions or even beneath them. But there are several other equally serious objections.

*Neues Jahrbuch fur Mineralogie 1886, Bd. II, Taf. IX, Fig. 3.

In the Comatula larva, which shows a decidedly bilateral symmetry, there are five equal basals and five equal orals. In *Thaumatocrinus*, although it has anal plates and a large proboscis, the basals and anals remain undisturbed. The same may be said of the basals of the Palaeocrinoidea and Blastoidea; among which not a single instance is known where the basal ring contains either anals or radials, contrary to the proximals, among which nearly always anals and often radials are enclosed. This shows that the presence of such plates, if the proximals in those groups represent the orals, and the latter the basals, would be totally at variance with the general rules of the class both as to orals and basals.

The anal plates of the apical side either abut directly against the radials, or are placed between the interradials. In most of the Camarata, the first interradial at the azygous side is split into two halves by the first or second anal piece. In others, the second anal is wanting, but the interradial is composed of two parts as if the anal were present. In a few groups there are no anal plates whatever, and the arrangement of the plates at all five sides is alike.

The same variations as among the interradials are found in the arrangement of the proximals,* of which the four large plates correspond to the calyx interradials at the four regular sides. The two smaller proximals, which occupy the azygous interradius, either are placed between two radial dome plates or they abut against two of the larger proximals, enclosing generally an anal plate—but this may be absent or pushed downard.

As yet, we have not observed a single instance in which there were five plates around a central one, but should it occur, which we think is very possible, we doubt if Messrs. Etheridge and Carpenter, although finding at last their "simpler form," will be able to make much out of it in support of their theories.

We stated heretofore that fig. A on p. 72 of the Blast. Cat. is erroneous, and this, to some extent is the case with fig. B on the same page. We never saw a *Platycrinus* with a single interradial, all having three (or more), arranged transversely. Besides, the figure is misleading in not giving the central piece and the so-called radial-dome plates. If these plates had been added, as they should have been to represent the case properly, it would show that the radial-dome plates are placed opposite the radials, the proximals opposite the interradials, and that the central piece takes orally the

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*For the arrangement of the proximals see Revision Pt. III, pp. 47 to 50.

position of the coalesced basal disc; a totally different thing from what the English authors attempted to prove by their figure.

We are altogether in accord with Goette and Carpenter in their opinion that the orals are represented in the abactinal system by the basals, but we disagree entirely with the latter writer that the basals are represented orally by the proximals. We regard the proximals as an element similar to the interradials, but, while these fill up vacancies in the calyx, the former fill the open space around the peristome as it widens in the growing animal by the increasing width of the dorsal cup. To this conclusion we were led principally by the arrangement of the plates, the presence of radial and anal plates in the same ring with them, and by their gradual appearance in geological times. We further believe the central piece is the only plate which in the Palaeocrinoidea and Blastoidea can possibly represent the quinque-partite oral pyramid. We regard it as being primitively composed of five pieces, such as remained intact persistently in *Stephanocrinus* and most of the Cystidea, but which were fused together by anchylosis in other groups as aborally in the case of the basals, which gradually were reduced from five to three, and in certain groups to one solid piece. The proximals, therefore, in our opinion, are not of that morphological importance as they are regarded by Dr. Carpenter, and we think the same may be said of the so-called radial dome plates. These also, like the proximals, seem to us mere auxiliary pieces, filling up vacancies, beneath which the branching of the ambulacra takes place. If they deserve the term radials at all, they certainly represent the axillaries, and not the oculars or first radials, except perhaps in some very complex species in which there appear three successive pieces to each ray, the inner ones resting against the central plate in a similar manner as the true radials rest against the basals; while the third or axillary one holds toward the proximals and the ambulacra the very same relations as the single radial does in the simpler form (See Revision Pt. III, Pl. IV, Fig. 4, and Pl. VIII, Figs. 1, 3.). It is also very significant that frequently in those complex forms there appear toward the center *within the ring of proximals* (orals of Ether. and Carp.), two extra axillaries underneath which the two lateral rays, which are united close to the peristome, divide so as to form the antero-and postero- lateral rays. How Dr. Carpenter will explain the presence of these plates within the "oral" ring, which is said to cover the origin of the ambulacra, is a mystery to us, and we look to him for in-

formation. The radial dome plates, as a rule, disappear when the ambulacra enter the surface, and this explains why they are absent in Blastoids,* *Stephanocrinus* and the later Cyathocrinidae.

We have already alluded to the fact that the proximals are frequently unrepresented in the earlier groups, in which, as a rule, the peristomial area is comparatively smaller than in later ones, and closed only by a small central piece. Upon this point it is very interesting that we have recently discovered the same thing in later groups under somewhat different conditions. In two cases, the one a species of *Talarocrinus* from the St. Louis group of Kentucky (Fig. 10), the other a *Dichocrinus* from the Kinderhook of Iowa, we found the whole space usually occupied by central piece and proximals, although as large as in any *Platycrinus*, filled completely by an enormous, nodose central plate, with the covering pieces abutting against it. Interposed between the ambulacra are a number of small interradial plates, which barely touch the central piece. In these cases, according to our interpretation, the increasing space of the peristomial area was filled by lateral growth of the orals (central piece), instead of by means of proximals. But according to Carpenter's generalizations (Challenger Report, p. 171), the insignificant interradials next to the central piece, and between the ambulacra, should be the representatives of the orals or else his rules would encounter another serious objection.

Dr. Carpenter regards both *Allagecrinus* and *Haplocrinus* as representing in a phylogenetic sense embryonic stages of the Palaeocrinoidea. If this be true, he has failed to give a reasonable explanation how the large plates covering almost the whole ventral side in these low forms, came to be placed in this group so as to occupy only the relatively small space they do in what he regards as higher developed forms. Etheridge and Carpenter undertook to prove it in their paper, Annals and Mag. Nat. Hist., Apr. 1881, p. 289, by imagining that, in the more mature specimens of *Allagecrinus* "the orals were relatively carried inwards, away from the radials, and separated from them by perisome (just as they are in the Pentacrinoid larva of Comatula) when the arms appear above the radials. Whether the orals ever separated so as to open the mouth to the exterior, and whether the ring of perisome forming the ventral disk

*Etheridge and Carpenter figure, Blastoid Catalogue on Pl. XVIII, Fig. 16, *Elaeacrinus Verneuili* with radial dome plates; none of our specimens show any traces of them.

between them and the radials was naked, as in *Rhizocrinus*, or plated, as in *Hyocrinus*, must of course remain undiscovered."

This explanation is suggestive enough of what may occur in the Neocrinoidea, but they fail to give a parallel case in which such a development as this took place in a single Palaeocrinoid, and this omission is the more important since they place the genus *Allagecrinus* in the latter group. They state afterwards (op. cit. p. 289). "It is true we have no proof that there were any orals at all in the older specimens; but, judging from the relative sizes and development of the largest examples with oral plates, and the smallest without, we think it scarcely likely that they were entirely unrepresented in the adult. It is obvious that, if they were united to the radials by perisome, whether plated or bare, they would be readily lost under conditions that would have had no destructive effect on younger specimens, in which there was a closer union between the two rings of plates."

From the foregoing quotation, it is obvious that the Authors desired to prove from the fact that the ventral plates were not found preserved in what they regarded as the most mature stages of the species, that they could not have rested upon the radials as in their younger examples, and that they were parted from the radials by perisome. Upon this proposition we will observe that we have never found among Palaeocrinoids the slightest evidence indicating to us that any of the summit plates were carried inward by perisome. We find that among the Camarata they occupy a comparatively small space, but larger than in the Blastoidea, and that in all cases in which they occur, they are supported by the upward growth of the interradials. In the simpler forms of the Inadunata, when observed, they rest upon a single interradial plate as in the case of the Silurian *Cyathocrinus alutaceous* (Ang.). In the Carboniferous form of *Cyathocrinus*, in which the ambulacra are placed upon the lateral edges of the interradials, the orals are not carried inward by perisome, but the perisome appears upon the surface of the interradial plates. That the ventral plates were not preserved in the so-called adult specimens of *Allagecrinus* is no proof that they did not exist, or that they were carried inward. The simple fact that the radials underwent the change from the horse-shoe form to a higher state of development, having strongly marked articular facets, extending to the whole width of the plates, is sufficient to explain why the interradials were not intact or reduced in the adult stages. We

need only refer to the parallel cases of Cyathocrinidae and Poteriocrinidae. In the former, in which the articular facets were comparatively undeveloped, we have been able, in a number of instances, to observe ventrally the interradial plates, which Etheridge and Carpenter formerly regarded as structually identical with the so-called orals of *Allagecrinus.* While in the Poteriocrinidae, in which the articular facets are highly developed, no trace of these plates has ever been found.

We, of course, do not claim that this is positive proof, that in *Allagecrinus* these plates were not carried inward by perisome, but it militates strongly against the probability of such a thing, while the theory that they were is at best but the merest conjecture. If Etheridge and Carpenter had placed *Allagecrinus* and *Haplocrinus* among the Neocrinoidea as larval forms, they might be much better warranted in supposing that the plates in question were orals, and were afterwards carried inward, but both forms have been referred by them to the Palaeocrinoidea, in which that mode of development is altogether unknown. The case of *Cyathocrinus* shows clearly that in the later types of the Inadunata the conditions of the Palaeocrinoidea remain unchanged. The summit plates are not carried inward by perisome, but occupy the same space as in the earlier forms, and the perisome is formed upon the outer surface of the interradials. (Revision, Pt. III, Pl. IV, Figs, 2, 3, 6.)

We should like to know upon what ground the authors maintain that those genera are Palaeocrinoids, when they interpret their structures according to the rules characteristic of the Neocrinoidea. They neither have an anal plate, nor does *Allagecrinus* show any such irregularity in the arrangement of its plates, as would of itself warrant a reference to the Palaeocrinoids. The only irregularity noticed in *Allagecrinus* is that the radials in some specimens may be axillary in one to four of the rays, or not axillary in any of them, and upon this character, curiously enough, Etheridge and Carpenter seem to have separated *Allagecrinus* from the Haplocrinidae and made it the type of a distinct family. On this alone it appears they divide it from the Neocrinoidea, as if it were one of the most constant characters among the Palaeocrinoids; while in fact this peculiarity is found only in the Catillocrinidae, in two of the rays of *Tribrachiocrinus*, and occasionally in *Allagecrinus.* A character like this is liable to be discovered exceptionally in any new form of Neocrinoids, just as well as among Palaeocrinoids, while among

the latter we find a number of genera, in which the arrangement of of the dorsal cup is altogether symmetrical.

It will not, of course, be inferred from the foregoing remarks that we think *Allagecrinus* and *Haplocrinus* belong to the Neocrinoidea, but simply that, if Messrs. Etheridge and Carpenter's arguments are valid, they necessarily lead to that conclusion. We think, on the contrary, there are the strongest reasons for considering them both to be Palaeocrinoids, and that there is no difficulty in discovering entire conformity in their morphological conditions with other Palaeocrinoids.

Whatever arguments Messrs. Etheridge and Carpenter may hereafter offer in favor of their oral theory, it seems to us, they will have to explain upon palaeontological grounds how the five large ventral plates of *Allagecrinus* and *Haplocrinus* which cover the *whole ventral surface* happen to occupy in all higher or more advanced forms a comparatively *small space* around the peristome. They will have to point out by what process the *five* plates, without coming in contact with the anus, were transformed into *six* pieces *or more;* and they will have to furnish better proof as to the existence of a so-called "orocentral," or they will have to modify their generalizations, which are based almost exclusively upon this highly hypothetical plate.

EXPLANATIONS OF FIGURES, PLATE IV.

(The following letters are employed throughout the figures).

o, Oral plate or oral pyramid; p, proximals; i, interradials; ia, interaxillaries; r, radials; a, anal plate; x, anus, g, grooves.

Fig. 1. Oral pyramid and surrounding plates of *Sphaeronites globosus* (after Angelin, Icon. Crin. Suec. Tab. XI, Fig. 14.)

2. Ventral aspect of *Cyathocrinus Gilesi.*
3. The same of *Stephanocrinus angulatus.*
4. The same of *Haplocrinus mespiliformis.*
5. Profile view of the same species.
6. Ventral aspect of *Caryocrinus ornatus* (after Hall, Palaeont. N. York, Vol. II, Pl. 41a, Fig. 1e).
7. The ventral plates of *Caryocrinus* from near Louisville, Ky. (The course of the subtegminal ambulacral tubes indicated upon the surface of the plates).
8. The same of *Juglandocrinus crassus* (after von Koenen, Jahrb. Miner. Bd. II, Taf. IX, Fig. 3.).
9. Ventral covering of a new *Talarocrinus* from Kentucky; the peristomial area closed by a large central plate without the aid of proximals.

10. The summit plates of *Elaeacrinus Verneuili* (after Eth. and Carp., Blast. Catal. Pl. XVIII, Fig. 16).

11. The same of *Elaeacrinus elegans* (from Hall's type in the National Museum of New York.)

12–14. The same of *Elaeacrinus obovatus*, as seen in different specimens. Fig. 12, all the sutures visible. Fig. 13, the suture between central piece and smaller proximals obliterated. Fig. 14, also those toward the small anal plate obliterated.

APRIL 5.

Rev. HENRY C. MCCOOK, D. D. in the chair.

Forty-four persons present.

Papers under the following titles were presented for publication:—

"The Terrestrial Mollusca inhabiting the Samoa or Navigator Islands." By Andrew Garrett.

"Notes on Fresh-water Rhizopods of Swatow, China." By Adele M. Fielde.

Note on the Multiplication of Distoma.—A note was read from MISS ADELE M. FIELDE, dated Swatow, China, Feb., 1887, to the effect that *Distoma* infests a species of snail found in many of the pools and wells near Swatow which is eaten, boiled, by the Chinese, and which is fed raw to ducks and geese. On dissecting, recently, an apparently healthy specimen, having a shell an inch long, she had found its liver almost wholly replaced by a *Redia*, the parent of the *Cercaria*, which being passively transferred to the alimentary canal of a vertebrate, develops into the *Distoma*. The life history of this trematode, as worked out by A. P. Thomas, is given in the Quarterly Journal of Microscopical Science, 1883, pp. 99–133, and *Limnæus* is mentioned as its host.

The *Rediæ* seen in the snails were of an orange yellow color and the largest were one-tenth of an inch in length. There were counted two hundred and fifty-three that were large enough to be easily isolated by the use of a needle point under the naked eye; and scores more, of smaller size and paler yellow, were visible under a lens. On opening several of the larger *Rediæ*, whose muscular mouths were active; they were found each to contain from eighteen to twenty-six *Cercariæ*, strong enough to whirl their tails vigorously, beside many embryos less fully developed. The *Cercariæ* moved rapidly over a glass slide by the use of their two suckers; and, merged in water, retained their vitality for thirty hours after being removed from the snail and the *Redia*. The one snail must have been the host of at least ten thousand larval Distomas.

APRIL 12.

Mr. CHARLES P. PEROT in the chair.

Thirty-one persons present.

The Placentation of the Two-toed Ant-eater, Cycloturus didactylus.—Prof. J. A. RYDER remarked that some months since Mr. J. W.

Scollick kindly placed in his hands an example of the uterus, containing a perfect fœtus of this interesting little arboreal South American Ant-eater. The only description of the fœtus and membranes of this animal which the speaker had been able to find, was by Mayer, in his *Analecta*, while Milne-Edwards has figured and described the fœtus and membranes of the allied form, *Tamandua*, in the "Annales des Sciences Naturelles."

The almost globular uterus, containing a well-developed fœtus, in the specimen exhibited at the meeting of the Academy, was about one inch in diameter. The placenta was relatively large, dome-shaped, or in the form of a disk, seven-eighths of an inch in diameter, much thickened in the center and becoming abruptly thin at its margin. Its outer or maternal surface was very convex and its inner or fœtal surface distinctly concave. The rather short, stout umbilical cord was attached at about the center of the disk and to its inner surface. The placental disk when carefully inspected upon its inner surface was found to be distinctly lobulated, somewhat as in the Sloths, as described by Sir Wm. Turner. The fissures which divided the placental disk were especially conspicuous when the edges of the disk were slightly bent by the fingers towards the convex side.

The uterine cornua were short, and the uterus was simple as in man and the sloths; the oviducts apparently quite small; the ovaries of strikingly unequal dimensions on opposite sides. No portion of the uterus was exserted or projected into the vagina as in man, but the walls of the vagina passed directly into those of the uterus. The vaginal mucous membrane was, however, deeply plicated in a longitudinal direction, these plications extending slightly into the cavity of the uterus.

The vessels of the cord are subdivided at their insertion into the placental disk; arterial and venous branches going to and from the several placental lobes, of which there were five, which could be distinctly made out.

On the inner surface of the uterine walls, there were apparently adherent portions of the fœtal and maternal tissues of the placenta, showing that this type is in all probability more or less deciduate, notwithstanding the fact that the uterine walls are relatively quite thin. The area embraced by the true chorion or placenta covered very nearly one-half of the inner surface of the globularly distended uterus. The false chorion made up the other half of the membranous investment of the fœtus and was quite thin and translucent. It covered with its outer surface about half of the inside of the uterus, or that hemisphere of the latter at the pole of which the vagina opened from without. The fœtus itself was well advanced, having as yet no outward hairy coat, nor could any traces of hair follicles be noted in the skin. No epitrichium was observed, though this may be developed at a later period, or after the hair is erupted from the follicles. The total length of the fœtus was nearly or quite three inches, of which the long stout tail formed more than a third.

The speaker then contrasted the various types of placentation, pointing out that it was largely a matter of how the blastodermic vesicle was primarily brought into relation with the walls of the uterus. If the fœtation occurred in the bicorned or tubular type of uterus there was an obvious tendency toward the diffuse or zonary type of placenta, as shown in Ungulates and Carnivora, and in those uniparous forms in which the fœtus occupies mainly one horn of the uterus, and in which there are bare poles to the chorion and a bare spot where the latter comes in contact with the os uterus as in the Mare and Dugong. Here, the mere mechanical relations of the fœtal and maternal surfaces obviously had had an influence in determining the form of the placenta. The zonary placenta was also imitated in Arthropods (*Peripatus*) in virtue of the existence of such similar conditions in both the latter and Carnivorous Mammalia. The speaker thought that all attempts to use the placenta as a means of clearly distinguishing the various orders of mammalia or of subdividing the latter into sub-classes would, in the course of further embryological research, be shown to be not well founded. This seemed all the more probable since the rationalé of the so-called "inversion" of the germinal rays of Rodentia was better understood. As a result of fuller knowledge it is hardly conceivable that a zonary placenta could be found in those types, notwithstanding the fact that they at first seem to present the same type of condition for the blastodermic vesicle in the uterine cornua as do the Carnivora. But now that we know that some of the Insectivora (*Talpa*) tend in the same direction the anomalies which are presented by Insectivora and Rodentia become explainable and lead us up to the view that, it depends (1) upon the mode in which the early development is modified, and (2) upon the manner in which the fœtus is related to the maternal surfaces, whether the diffuse, zonary or discoidal form of placenta will be assumed.

In the case of the Sloths and Ant-eaters, of South America, the uterus has attained a remarkable degree of specialization, so as to greatly resemble the simple uterus of the higher Primates, and in this case again, the relationship between the form of the uterine cavity and that of the placenta seems obvious, for in the sloths, ant-eaters and higher primates, the placenta is essentially discoidal and deciduate. In the sloth, however, Turner has shown the discoidal placenta to be made up of separable lobes; these may be conceived as representing the cotyledons of Ungulates, or groups of tufts in the diffuse type of placenta, which have been crowded together as the uterine cornua became shortened on the mesometric side, in the transition from the bifid to the simple type of uterus. Some further ground for this view of the origin of the lobulated discoidal, dome-shaped placenta of the sloths is supplied by the fact that in *Manis*, or the scaly Ant-eater of the Old World, the placenta is diffuse and non-deciduate. In some of the Armadilloes the placenta is transversely oblong, and this again is a fact favorable to the preceding view.

In like manner, the terms "deciduate" and "non-deciduate" do not serve to sharply mark off groups from each other, but probably rest for their distinction upon the more or less intimate and complex interlocking of the fœtal and maternal membranes during their functional activity. So that in this case again we are dealing with structures and structural conditions differing only in degree but not in kind. The extra thickening of the decidua or uterine mucosa in the extremest type of deciduate placenta, may be regarded as correlated with the restriction, concentration or reduction of the placental area and the formation of a decidua serotina. Finally, it is proper to call attention to the fact that the American Edentata are more specialized as respects their placentation than those of the Old World. The American forms, further, generally agree amongst themselves, except that in the Armadilloes, Milne-Edwards, Kölliker and Von Jhering have observed that, in some species, there may be a number of fœtuses invested by a common chorion, on which account, the latter author has supposed that such a compound embryo is the result of the fragmentation or subdivision of a single egg, a phenomenon of metagenesis to which he has applied the appropriate term *Temnogeny.*

Sugar in China.—At the recent meeting of the Botanical Section, Mr. THOMAS MEEHAN read the following extract from a letter of Miss Adele M. Fielde, a missionary in China. The letter is dated from Swatow. "My attention has lately been called to an error, existing apparently in many minds, concerning the plant from which sugar is made in China. A late consular report from Canton says the plant is a species of Sorghum, and in the American Cyclopædia (Appleton, 1863), the article on Sorghum appears to me to convey the same idea. I send you to-day flowers of the plant cultivated very extensively for the sugar in the neighborhood of Swatow, and which is the source of the chief export of this treaty port. It seems to me no sorghum, but by the description in botanical works, the true *Saccharum officinarum.* Tell me whether it differs from the plant from which sugar is made in the Southern United States. Propagation is from cuttings,—a section of the culm, a foot long, being set out at each planting. This planting is done in February, and is ready to be cut for pressing out the juice eleven months later. In the fourth year the stubble is removed, and new cane is planted. It is not allowed to flower, as the cultivators say it spoils it for use in sugar making." Mr. Meehan said he could scarcely understand how the idea should get currency that Sorghum yielded the sugar of China, for though the native country of the true sugar cane is unknown, the civilized world is indebted to China for the first knowledge that what we know as sugar could be extracted from the cane. Manufactured sugar from this cane was known in China before it was known in Europe. As for Sorghum, though sugar could be made from it, it had been found so unreliable for that purpose, depending apparently more on

some chemical accident than on vital power, that it was doubtful if sugar in any quantity had ever been made from it in China or anywhere else. Certainly the specimens sent by Miss Fielde were of the true sugar cane, as grown by us in the Southern States.

Floral Calendars.—In regard to the times of flowering of plants, MR. MEEHAN exhibited blooms of the winter Aconite, *Eranthus hyemalis*, and the Snowdrop, *Galanthus nivalis*, which this year were blooming together on the 10th of April. In other seasons the same plants, growing side by side, had given flowers of the winter Aconite, several weeks before the Snowdrop. The explanation was that some plants would start into growth at a lower temperature than others. The Snowdrop would remain at rest under a low temperature quite sufficient to excite the Aconite. In a season when the thermometer remained regularly lower than sufficient to excite growth in the Aconite, the plant remained quiescent until the warmer spring weather brought forward both kinds together. These facts showed that no such a scheme as a floral calendar could be established, as the relative blooming of plants depended on accidents of temperature rather than on any fixed climatal conditions.

Cortical Peculiarities in the Plum.—Some specimens of supposed hybrids between the Peach and the Plum were sent to the Academy for examination. The chief reasons for the belief that they were hybrids were that they were sterile, and seemed in leaf and branches intermediate between the two species. MR. MEEHAN observed, that in hybrids between acknowledged species, it did not follow that the characters should be intermediate. Often there would be scarcely any trace of the action of the male parent, while at other times the male would seem to have had a leading influence. But these plum branches showed no trace of any intermediate characters, but were purely plum branches, with no sign of the Peach character about them.

He said he had called the attention of the Academy on several occasions in the past to the fact that the bark of trees did not crack from the mechanical pressure of wood-growth, as so often taught in botanical text-books, but the rifts arose from the peculiar growth of cork cells, and it was the character and general direction of these growths, apparently different in species, that gave the varied characters to tree bark,—characters that were more or less constant in each species of tree. A tree could in fact be nearly as well known by its bark as by its fruit. The development of the cork cells destroyed the cuticle. In the Cherry and Birch the chief development was in a lateral direction, and hence we could easily strip sections from around branches. In the Abele Poplar the development destroyed the bark to a considerable depth, and in a quadrangular form. These gradually met at the points and at once formed deep furrows up and down the stem. In the Plane and some other trees, the cork cells worked up and down under thick layers of bark which it threw off in flakes. But the chief distinc-

tion was in the period of life when they assumed activity. In the Chestnut (*Castanea*) it was nearly 25 years before they grew into destructive agencies, and hence there was smooth bark to the Chestnut for nearly a quarter of a century. In the oak rough bark from the development of the cork cells, began at about ten years, in the Sassafras at five years,—in some they started at one and occasionally the same season. In the Beech they grew the first season, and only worked under the outer cuticle, which they threw off as fine film annually. Handling a branch of Beech at some seasons, a filmy deposit would be left in the hands, which was the fine silky bark of the Beech. Hence the Beech had never rough bark. This fact should show mechanical action had no part in rifting the bark. Mechanical action should split a Beech as well as any other tree.

Returning to the Plum, he remarked that the development of the cork cells were in many respects the same as in the Beech. They started on their destructive errand before the annual growth was fairly over, destroying the thin outer cuticle as it progressed. It was this that gave the silvery tint to Plum wood with which all must be familiar. This was never seen on Peach wood. This character was exhibited in all the samples of supposed hybrids sent. There was nothing whatever to distinguish them from pure Plums so far as this character was concerned.

As for the flowers, the plants were sterile because of peculiar abortion in the reproductive organs. The carpels instead of being consolidated, ending in a single style as in the ordinary Plum, had become distinct, and they were ten processes difficult to say whether they resembled stamens or pistils most. There were no attempts to form perfect stamens or petals,—but the bud scales had a faint rosy margin as if there existed a slight disposition to make petals out of them. They were remarkable examples of monstrosity in Plum flowers, but nothing to indicate any action of the Peach therein. They were evidently sterile because they were monstrous, and not that they were hybrids. The foliage had a more peachy look than customary with Plums, so far as mere outline was concerned,—but it is well known that when there was a disturbance of sexual characters, the whole system of growth was apt to be disturbed. It was possible the Plum and the Peach would hybridize. It would be of much interest to science could the possibility be proved a fact. It was due to science to say these specimens did not prove it. The chief interest in the specimens, he thought, dwelt in the fact that amidst all the changes in characters brought about by some abnormal agency, the cortical peculiarities as influenced by the cork cells remained the same.

April 19.

The President, Dr. Leidy, in the chair.

Fifteen persons present.

APRIL 26.

Mr. CHARLES MORRIS in the chair.

Twenty-three persons present.

The following letter was read:—

Board of Trustees of the Building Fund,
Academy of Natural Sciences of Philadelphia,
April 25, 1887.

DR. JOS. LEIDY,
President of the Academy of Natural Sciences of Philadelphia,
Dear Sir:—

I have the pleasure to inform you that in conformity with a recommendation of the Council and requisition of the Academy, the title of the land on the west side of Nineteenth Street between Race and Cherry Streets, with the buildings erected thereon, heretofore held in trust for the society, has been lawfully conveyed in fee simple to the Academy of Natural Sciences of Philadelphia; and that the deed has been duly recorded and deposited in the fire proof of the Academy.

I am very respectfully,
Yr. Obt. Servant,
W. S. W. RUSCHENBERGER,
Chairman Trustees of Building Fund.

Ovo-viviparous Generation in Tropidonotus.—Professor Heilprin presented the following communication, dated April 15, 1887, from MR. H. C. YOUNG, of the Philadelphia Custom House, referring to a water-snake shot by that gentleman some fourteen years ago, at a locality about three miles above Salem, N. J. "Upon examining the snake (which was almost as thick as my fore arm) I found it contained considerable of a bunch which I supposed to be something it had swallowed, but upon cutting it open I found it contained small snakes in a bag, each one in a separate division formed as it were by a twist in the bag. I took them out and found there were 33 of them of different sizes a number of the smaller ones having a portion of an egg attached to them, which they appeared to be absorbing, the larger ones having had already absorbed theirs. I was then convinced that while the land-snakes lay eggs in the earth to be hatched by the heat of the sun, the young of the water-snake are actually hatched in the belly of the mother." Prof. Heilprin stated that the snakes had been presented by Mr. Young to the Academy, and on examination proved to be *Tropidonotus sipedon*. The case demonstrated beyond a question of doubt that the species was ovo-viviparous.

Prof. Henry A. Ward, of Rochester, was elected a correspondent.

The following were ordered to be printed:—

NOTES ON FRESH-WATER RHIZOPODS OF SWATOW, CHINA.

BY ADELE M. FIELDE.

During the month of February, in ooze taken from the pools and ditches near my house, and preserved in soup-plates under water an inch in depth, I have seen *Amœba radiosa, Amœba verrucosa, Difflugia pyriformis, Difflugia acuminata, Difflugia cornuta, Difflugia corona, Difflugia nodosa, Difflugia compressa, Difflugia spiralis, Difflugia lobostoma, Difflugia globulosa, Arcella vulgaris, Arcella discoides, Centropyxis aculeata, Centropyxis ecornis,* with the empty shells of *Euglypha alveolata,* and the Heliozoans, *Actinophyrs sol, Actinophyrs picta, Actinosphærium,* and *Acanthocystis.* Of *Difflugia spiralis,* the greater number had shells formed of vermicular pellets. In *Difflugia lobostoma* the mouth of several specimens seen, was six lobed, and the shell of a glossy brown, ovoid or spherical, and so constructed of oval plates mingled with sand grains as to resemble *Nebela.* I have also seen several empty shells of *Difflugia cratera,* of bright brown membrane, and of the shape shown in Fig. 20, Plate XII, in Leidy's work on Rhizopods. These shells were only $\frac{1}{1000}$ of an inch in length, and had no sand grains adherent.

All the above species and varieties having been fully described and illustrated by Leidy, in his book on the Fresh-water Rhizopods of North America, I note their presence here only in order to record the interesting fact of their wide distribution.

In addition to the above, I have found another species, not described by Leidy, which has been identified with *Difflugia triangulata,* Lang, (*Difflugia bipes,* Carter). From the cancellated character of the shell this form probably belongs to the genus *Nebela,* Leidy. Another species observed is probably the *Nebela collaris,* Leidy.

The specimens of the form regarded as *Difflugia* (*Nebela*) *triangulata* vary but little in size in a great number of specimens observed, averaging $\frac{1}{200}$ of an inch in length, with a mouth $\frac{1}{1000}$ of an inch in diameter; with two horns on the lateral borders of the fundus, the horns being usually $\frac{1}{1000}$ of an inch in length, and placed in different specimens at very different angles to the long axis of the shell. In some specimens a protuberance rises midway between the horns. The greatest diameter of the shells

varies considerably with the inclination of the horns, a difference of $\frac{1}{1000}$ of an inch being observed in different specimens having the same length, $\frac{1}{400}$ to $\frac{1}{300}$ of an inch being common. The transverse diameter is always about half that of the broad diameter,—narrowing gradually to the cylindroid mouth. The hexagonal cancellations are about $\frac{1}{4000}$ of an inch in diameter, their regularity varying. The sarcode in the specimens observed occupied not more than half the interior capacity of the shell, pyriform in shape, with never more than three pseudopods projected. A current of water directed into the mouth of a shell, caused, in one instance, the *instant* retraction of two long pseudopods, and the carrying of the whole mass of sarcode to the fundus of the shell.

The shell of *Nebela collaris*, Leidy, is obovate in the broad aspect, and the fundus is edged with what looks like a row of tiny bubbles. In the lateral aspect, the shell is generally pyriform, with an acute fundus. The length of the shell is about $\frac{1}{250}$ of an inch, and its greatest breadth $\frac{1}{300}$, the proportions varying but slightly in many specimens observed. The sarcode is the same as in *Difflugia cornuta*, and many specimens were observed with the sarcode formed into a ball in the center of the shell. The sarcode of all specimens seen, contained numerous brown granules and brown or greenish food-balls, similar in color to the diatoms and desmids associated with all these Rhizopods.

THE TERRESTRIAL MOLLUSCA INHABITING THE SAMOA OR NAVIGATOR ISLANDS.

BY ANDREW GARRETT.

The earliest notice we have of the land-shells of the Samoa Islands, was published by Dr. Gould in the "Proceedings of the Boston Society of Natural History" for 1846 and 1847, and subsequently redescribed and figured in the "Mollusca and Shells of the United States Exploring Expedition." He described 14 new species.

In 1865, Prof. Mousson published in the French Journal of Conchology a list of the land and fresh-water shells of Samoa, based on the collections made by Dr. Gräffe. He enumerated 29 species of land-shells, 14 of which were new to science. In 1869 he published a second list in the same journal and brought the number of species up to 48, 11 of which were described as new.

In the following pages the writer records 65 species, 32 of which are endemic; the others having a more or less extensive range throughout Polynesia.

MICROCYSTIS, Beck.

M. Upolensis, Mousson.

Nanina Upolensis, Mousson, Jour. de Conch., 1865, p. 166; (*Microcystis*) 1869, p, 327, 1870, Var. *Oneataensis*, p. 114. (*Thalassia*) Paetel, Cat. Conch., p. 85. Schmeltz, Cat. Mus. Godeff., v, p. 90.

Helix Upolensis, Pfeiffer, Mon. Hel., v. p. 108.

Helicopsis Upolensis, Pease, Proc. Zool. Soc., 1871, p. 475.

Helix Samoensis, Baird, French Cruise of the Curacoa.

I gathered numerous specimens of this species in the forests back of Apia village at Upolu Island, where Dr. Gräffe found the type examples. The Doctor subsequently discovered it at Vanua, Balavo, and Oneata in the Viti Islands.

It may be characterized by its depressed orbicular form, smooth, highly polished surface, pale horn color, 5 slightly convex whorls and slightly nodulous columella. Diam. 6½ mill. A strictly terrestrial species, living beneath decaying leaves and under rotten wood.

M. perpolita, Mousson.

Nanina (*Microcystis*) *perpolita*, Mousson, Jour. de Conch., 1869, p. 326, pl. 14, fig. 1; 1870, p. 113; 1871, var. *solida*, p. 8. Schmeltz, Cat. Mus. Godeff, v. p. 90.

Helicopsis perpolita, Pease, Proc. Zool. Soc., p. 475.

Helix perpolita. Pfeiffer, Mon. Hel., vii, p. 65.

A number of examples occured to my notice in the same station and location as the preceding species. It is also recorded from the Tonga and Viti Islands.

It may be known by its convexly-depressed form, 4½ convex whorls, polished surface and yellowish horn-color. Diam. 7 mill.

M. ensifera, Mousson.

Nanina (*Gastrodonta*) *ensifera*, Mousson, Jour. de Conch., 1869, p. 328, pl. 14, fig. 2.

Helicopsis ensifera, Pease, Proc. Zool. Soc., 1871, p. 475.

Helix ensifera, Pfeiffer, Mon. Hel., viii, p. 259. This small species, which is unknown to me is simply accredited to "Samoa" and was discovered by Dr. Gräffe.

It may be easily determined by its diminutive size (2 mill. in diam.), depressed-globose form, thin, pellucid texture, highly polished surface, minutely perforated base and plicated columella. Within the aperture are two lamelliform teeth, the upper submedian and the latter close to the base of the columella.

? M. Tutuillæ, Cox.

Helix Tutuillæ Cox, Proc. Zool. Soc., 1870, p. 83. Pfeiffer, Mon. Hel., vii., p. 64.

I am unacquainted with this species which was discovered by Mr. Brazier at Tutuilla.

Dr. Cox says it is a small, imperforated, depressly-conical species of a pale brownish color, the upper parts minutely granulated, base smooth and shining, and the wide suture is canaliculated. It has 5 rounded whorls, the last not depressed or carinated, lip thin and the aperture is roundly lunate. "Diam. maj. 0,12, min. 0,10, alt. 0,09, poll. (Cox.)

TROCHONANINA, Mousson.

T. Samoensis, Mousson.

Nanina Samoensis, Mousson, Jour. de Conch., 1865, p. 165

Helix Samoensis, Pfeiffer, Mon. Hel., v, p. 70.

Zonites (*Conula*) *Samoensis*, Mousson, Jour. de Conch., 1869, p. 331; 1870, p. 116; 1871, p. 10. Paetel, Cat. Conch., p. 86. Schmeltz, Cat. Mus. Godeff, v, p. 90.

Helix Clayi, Liardet, Proc. Zool. Soc., 1876, p. 101, pl. 5, fig. 7.

Microcystis Samoensis, Garrett, Jour. Phil. Acad. Nat. Sci., 1881, p. 384.

Not uncommon beneath decaying vegetation. It is also found in the Tonga, Viti, Cook's and Marquesas Islands.

It may be determined by its small size (3 mill. in diam.), perforated base, depressed turbinate form, reddish or brownish horn color, 5 strongly convex whorls and angulated periphery.

T. microconus, Mousson.

Nanina microconus, Mousson, Jour. de Conch., 1865, p. 192. (*Thalassia*) Paetel, Cat. Conch., p. 85.

Helix microconus, Pfeiffer, Mon. Hel., v, p. 94.

Zonites (*Conulus*) *microconus*, Mousson, Jour. de Conch., 1870., p. 117. Paetel, Cat. Conch., p. 86. Schmeltz, Cat. Mus. Godeff., p. 90.

Helix Pinnocki, Liardet, Proc. Zool. Soc., 1876, p. 100, pl. 5, figs. 5, 5a.

This, like the preceding species, lives beneath decaying vegetation and is also found in the Viti and Tonga Islands.

A minute, perforated, conical, grayish horn-colored species with 5½ spirally striated whorls, the last one acutely angulated and the base smooth.

T. Schmeltziana, Mousson.

Nanina Schmeltziana, Mousson, Jour. de Conch., 1865, p, 167. 1869. (*Trochonanina*), p. 329, pl. 14, fig. 4. Schmeltz, Cat. Mus. Godeff., v, p. 91. (*Thalassa*) Paetel, Cat. Conch., p. 85.

Helix Schmeltziana, Pfeiffer, Mon. Hel., v, p. 58.

Trochomorpha Schmeltziana, Pease, Proc. Zool. Soc., 1871, p. 474.

I found two examples of this delicate species on the foliage of shrubs on the low lands near the sea-shore at Upolu.

Its most essential characters are its thin delicate texture, smooth imperforated base, depressed conical form, luteous-horn color, margined suture, 5½ slightly convex whorls, the last one acutely and compressly carinated. The upper whorls are spirally striated, the striae scarcely visible without the aid of a lens. Diam. 9, height 6 mill.

Mousson (in Jour. de Conch., 1869, p. 30) describes a var. *usurpata* which is more elevately conical and the keel not so acute. It inhabits Savaii and is probably a distinct species.

TROCHOMORPHA, Albers.

T. Troilus, Gould.

Helix (*Carocolla*) *Troilus*, Gould, Proc. Bost. Soc. Nat. Hist.,

1846, p. 176; Exp. Exp. Shells, p. 58, fig. 55, Pfeiffer, Mon. Hel., i, p. 123; iii, p. 158, (*Videna*) Vers., p. 132. Chem. ed. 2d, Helix, p. 270, pl. 109, figs. 25. 26. Mousson, Jour. de Conch., 1865, p. 170, Schmeltz, Cat. Mus. Godeff., v, p. 94.

Nanina (*Discus*) *Troilus*, Albers, Die Hel., ed. 2d, p. 62. Paetel, Cat. Conch., p. 85.

Trochomorpha Troilus, Mousson, Jour. de Conch., 1869, p. 333. Pease, Proc. Zool. Soc., 1871, p. 474. Semper, Phil. Land-Moll., ii, p. 114, pl. 12, fig. 11.

Abundant beneath decaying leaves in forests at Upolu.

This species is of a depressed turbinate form, with a moderate umbilicus, 5½ convex whorls, the last one angulated and the color variable: fulvous, chestnut, corneous, luteous, unicolor or with two chestnut bands one above and one beneath the angulated periphery. Sometimes there is only a single spiral line on the upper surface. Diam. 18 to 20 mill.

T. tuber, Mousson.

Trochomorpha tuber, Mousson, Jour. de Conch., 1869, p. 334, pl. 14, fig. 5, Pease, Proc. Zool. Soc., 1871, p. 474.

Helix tuber, Schmeltz, Cat. Mus. Godeff., v, p. 95, Pfeiffer, Mus. Hel., vii, p. 278.

The habitat and station is the same as the preceding species but is much more rare.

This rather small species may be characterized by its obtuse conical form, perforated base, yellowish horn color and two narrow chestnut bands, one above the other beneath the periphery. Whorls 5½, convexly-rounded and the last one very slightly angulated. Diam. 12, height 9 mill.

T. subtrochiformis, Mousson.

Helix trochiformis, Gould (not of Ferussac), Exp. Exp. Shells, p. 61.

Helix Eurydice, Mousson (not of Gould), Jour. de Conch., 1865, p. 170.

Trochomorpha sub-trochiformis, Mousson, Jour. de Conch., 1869, p. 335, pl. 4, fig. 6; 1870, var. *albo-striata*, p. 122. Pease, Proc. Zool. Soc. 1871, p. 474.

Helix sub-trochiformis, Schmeltz, Cat. Mus. Godeff., v, p. 95. Pfeiffer, Mon. Hel., vii, p. 289.

Abundant at Upolu and Savaii.

A depressed pyramidal species with a moderate umbilicus, rounded apex and 5½ slightly convex whorls, the last one acutely and compressly keeled. The rude and irregular striæ of growth resemble interrupted pale scratches. Color luteous, or straw-yellow with a dorsal and basal reddish-chestnut band. Diam. 17 mill.

Prof. Mousson has described a variety from Kanathia, one of the Viti Islands, under the name *albo-striata*. It is probably a distinct species.

T. tentoriolum, Gould.

Helix tentoriolum, Gould, Proc. Bost. Soc. Nat. Hist., 1846, p. 176; Exp. Exp. Shells, p. 63, fig. 53. Pfeiffer, Mon. Hel., p. 119.

Trochomorpha tentoriolum, Mousson, Jour. de Conch., 1869, p. 335. Pease, Proc. Zool. Soc., 1871, p. 474.

Dr. Gould who described this species from examples collected by the United States Exploring Expedition cites "Upolu" as its habitat. As it has not been noticed by subsequent explorers its existence in that group certainly needs confirmation.

It is a small, trochiform pale greenish species with rounded apex and 6 flattened whorls which are beautifully striated and the last one acutely carinated. Diam. 9, height 7 mill.

T. navigatorum, Pfeiffer.

Helix navigatorum, Pfeiffer, Proc. Zool. Soc., 1854, p. 55; Mon. Hel., iv, p. 114; (*Videna*) Vers., p, 132. Reeve, Conch. Icon., no. 1303, pl. 187.

Trochomorpha navigatorum, Pease, Proc. Zool. Soc., 1871, p. 474.

Dr. Pfeiffer described this species from specimens in the Cumingian Collection which were labelled "Navigator Islands." Like the preceding species the above habitat is questionable.

Pfeiffer says it is a moderately umbilicated, solid, lentiform species of a purplish-brown, or reddish-grey color, with an obtuse, convex spire, marginated suture and 6 slightly convex whorls, the last one compressly carinated. Diam. 18½, height 7½ mill.

T. luteo-cornea, Pfeiffer.

Helix luteo-cornea, Pfeiffer, Proc. Zool. Soc., 1854, p. 56; Mon. Hel., iv, p. 186, (*Videna*) Vers., p. 132. Reeve, Conch. Icon., no. 1287, pl. 186.

This, like the preceding species, is described from specimens in

Cuming's Collection, labelled "Navigator Islands." It has not been identified by either Prof. Mousson or myself.

The description refers to a solid, lenticular, conoidal luteous-horn colored species with a moderately sized umbilicus and five regular striæ. Whorls 5, convex, the last one angulated.

T. Samoa, Hombron and Jacquinot.

Helix Samoa, Hom. et Jacq., Voy. Pol Sud., Zool., v, p. 11, pl. 4, figs. 28-31. Pfeiffer, Mon. Hel., iv, p. 69.

Helicopsis Samoa, Pease, Proc. Zool. Soc., 1871, p. 475.

This species which has not been identified since the above naturalists published their description, may possibly be a form of Gould's *Troilus*. They give the habitat "Upoulon"= Upolu.

They describe it as having a medium sized umbilicus, conoidal form, rather fine striae, luteous color with two fuscous lines, and 5½ whorls, the last one subangular; base convex, aperture lunate and the peristome simple. Diam. 18, height 10 mill.

PATULA, Held.

P. gradata, Gould.

Helix gradata, Gould, Proc. Bost. Soc. Nat. Hist., 1846, p. 172; Exp. Exp. Shells, p. 49, fig. 48. Pfeiffer, Mon. Hel., i, p. 104. (*Charopa*) Paetel, Cat. Conch., p. 90.

Discus gradatus, H. and A. Adams, Gen. Moll., ii, p. 117.

Patula gradata, Mousson, Jour. de Conch., 1865, p. 168; 1869, p. 333; 1871, p. 12.

Pitys gradata, Pease, Proc. Zool. Soc., 1871, p. 474.

Common beneath decaying vegetation and is probably distributed throughout the group. It is common also to the Tonga Islands.

A small,. orbicular, depressed, widely umbilicated species with 5 convex whorls, the last one subangulated on the margin of the broad umbilicus and the delicate striæ of growth are cancellated by five revolving impressed lines. Aperture sub-orbicular, color pale olivaceous with radiating rufous spots. Diam. 6 mill.

P. complementaria. Mousson.

Patula complementaria, Mousson, Jour. de Conch., 1865, p. 168, pl. 14, figs. 5, 1869, p. 333.

Helix complementaria, Pfeiffer, Mon. Hel., v, p. 157. (*Patula*) Paetel, Cat. Conch., p. 89.

Pitys complementaria, Pease, Proc. Zool. Soc., 1871, p. 474.

A rare species found beneath rotten wood and under decaying leaves in the forests back of Apia village, Upolu.

It is a little smaller than *gradata* and the umbilicus is only moderately open. The spire is depressed, suture deep, whorls 5, with transverse, crowded, sharp rib-like striæ. Color corneous, tessellated and radiately striped with chestnut.

P. allecta, Cox.

Helix allecta, Cox, Proc. Zool. Soc., 1870, p. 81. Pfeiffer, Mon. Hel., vii, p. 162.

I am unacquainted with this species which was found at Upolu.

Dr. Cox says it is a minute, depressed, orbicular reddish-chestnut species, with closely-set strong striæ, 4½ to 5 convex whorls, deep suture and the broad umbilicus is saucer shaped.

PITYS, Beck.

P. hystricelloides, Mousson.

Patula hystricelloides, Mousson, Jour. de Conch., 1865, p. 169, pl. 14, fig. 6. (*Endodonta*) 1869, p. 331. Schmeltz, Cat. Mus. Godeff., v, p. 93.

Helix hystricelloides, Pfeiffer, Mon. Hel., v, p. 221. (*Patula*) Paetel, Cat. Conch., p. 91.

Pitys hystricelloides, Pease, Proc. Zool. Soc., 1871, p. 474.

Not uncommon under rotten wood and beneath decaying leaves. Upolu.

This species may be determined by its depressed rounded form, curved costulate striæ, depressed spire, 5½ whorls, and more particularly by the numerous laminæ in the aperture, of which there are from 3 to 4 on the parietal region and 6 to 8 in the palate. The umbilicus is about one-fifth the diameter of the shell. Diam. 4½ mill.

P. Graeffei, Mousson.

Patula (*Endodonta*) *Graeffei*, Mousson, Jour. de Conch., 1869, p. 332, pl. 14, fig. 3.

Helix Gräffei, Pfeiffer, Mon. Hel., vii, p. 258.

Pitys Gräffei, Pease, Proc. Zool. Soc., 1871, p. 474.

I am not acquainted with this species which was found at Upolu by Dr. Gräffe.

It is a little larger than the preceding species, with a more open umbilicus, 5 whorls, and 2 laminæ on the parietal wall and 5 in the palate. "Diam. 5-2 mill.

STENOGYRA, Shuttleworth.

S. Tuckeri, Pfeiffer.

Bulimus Tuckeri, Proc. Zool. Soc., 1846, p. 30; Mon. Hel., ii, p. 158; (*Opeas*) Vers., p. 156, Reeve, Conch. Icon., pl. 68, sp. 481. (*Opeas*) Cox, Mon. Aust. Land Shells, p. 69, pl. 13, fig. 9, Brazier, Quar. Jour. Conch., i, p. 272.

Stenogyra Tuckeri, Albers, Die Hel., ed. 2d. p. 265. (*Opeas*) Frauenfeld, Verh. Zool.-Bot. Wien, xix, p. 873. Pease. Proc. Zool. Soc., 1871, p. 473. Garrett, Jour. Acad. Nat. Sci. Phila., 1881, p. 393, 1885, p. 43.

Bulimus junceus, Gould, Proc. Bost. Soc. Nat. Hist., 1846, p. 191; Exp. Exp. Shells, p. 76, fig. 87. Pfeiffer, Mus. Hel., ii, p. 220.

Stenogyra juncea, Mousson, Jour. de Conch., 1869, p. 340. Pease Jour. de Conch., 1871, p. 93; Proc. Zool. Soc., 1871, p. 473. (*Opeas*) Paetel, Cat. Conch., p. 104. Schmeltz, Cat. Mus. Godeff., v, p. 90. Garrett, Proc. Acad. Nat. Sci. Phila., 1879, p. 19.

Bulimus Walli, Cox, Cat. Aust. Land Shells, p. 24. Pfeiffer, Mon. Hel., vi, p. 99.

Stenogyra Upolensis, Mousson, Jour. de Conch., 1865, p. 175. (*Obeliscus*) Paetel, Cat. Conch., p. 104. Schmeltz, Cat. Mus. Godeff., iv, p, 29.

Bulimus Upolensis, Pfeiffer. Mon. Hel., iv, p. 100.

Bulimus Panayensis, Pfeiffer, Proc. Zool. Soc., 1846, p. 33; Mon. Hel., ii, p. 156; (*Opeas*) Vers., p. 156. Reeve, Conch. Icon., pl. 14, no. 76. (*Opeas*) Albers, Die Hel., p. 175.

Subulina Panayensis, H. and A. Adams, Gen. Moll., ii, p. iii. Semper, Phil. Land-Moll., ii, p. 137, pl. 8, fig. 15.

Stenogyra Panayensis, (*Opeas*), Albers, Die Hel., ed. 2d., p. 265. Martens, Ostas. Zool., ii, p. 83, (Siam), 376, pl. 22, fig. 8. (*Opeas*) Paetel, Cat. Conch., p. 104.

Bulimus diaphanus, Gassies (not of Pfeiffer), Jour. de Conch., 1859, p. 370.

Bulimus Souverbianus, Gassies, Faune Nouv. Caled., p. 52, pl. 2, fig. 5. Pfeiffer, Mon. Hel., vi., p. 98.

Bulimus Artensis, Gassies, Jour. de Conch., 1866, p. 50. Pfeiffer, Mon. Hel. vi, p. 98.

Stenogyra novemgyrata, Mousson, Jour. de Conch., 1870, p. 126. (*Subulina*), Paetel, Cat. Conch., p. 104. Schmeltz, Cat. Mus. Godeff., v, p. 90.

Bulimus novemgyratus, Pfeiffer, Mon. Hel., viii, p. 138.

Stenogyra gyrata, Mousson MS., in Mus. Godeffroy, 1885.

This species, which is distributed over a larger geographical area than any other species of land-shell, is diffused throughout all parts of Polynesia, the low coral islands as well as the more elevated groups, and ranges throughout Melanesia, Micronesia, Australasia, Moluccas, Philippines, Guam, Ceylon, Siam, Cochin China, China, and probably extends its range as far as the East coast of Africa.

Since the publication of my paper on the Society Island land-shells I have received from Mr. E. L. Layard, examples of *Bulimus Souverbianus* and *B. Artensis*, both of which are identical with Polynesian specimens of *S. Tuckeri*.

Through the kindness of Dr. Hungerford, of Hong Kong, I have been enabled to compare Pfeiffer's *Bulimus Panayensis* with *B. Tuckeri* and cannot detect a single character to separate the two species.

I am strongly inclined to believe that the West Indian *Stenogyra subula*, Pfr., is a form of the Polynesian *S. Tuckeri*, and was accidentally imported with the Tahitian bread-fruit plants nearly 100 years ago. M. M. Crosse and Fischer (Jour. de Conch., 1863, p. 361), record the West Indian *Bulimus subula* from Cochin China, and give a good figure of the same, which is, undoubtedly, the ubiquitous *S. Tuckeri*. I reproduce their remarks as follows:—

"Cette espèce provient de Saigon et de Fuyen-Moth, où elle a été recueillie, par M. Michau, dans les fossés, dans la terre et sous les herbes. Il peut sembler très-extraordinaire de retrouver en Cochinchine une espèce des Antilles, qui n' a guère été signalée jusqu' ici qu'à Cuba, à la Jamaïque et à Saint-Thomas. Pour ne conserver aucun doute à son égard, nous avons cru devoir soumettre un individu authentique à l' examen de M. Pfeiffer, qui a créé l' espèce. Il faut donc accepter le fait, qui peut être, au reste, seulement un accident d' acclimatation: la petitesse et la légèreté de la coquille en question rendent cette supposition vraisemblable."

I have lately received from Dr. Hungerford, several examples of *Stenogyras*, labelled "*Opeas subulata* Pfr., Hong Kong" which differed none from the Polynesian *S. Tuckeri*.

This species, which is chiefly confined to the low-lands near the sea-shore, is found beneath decaying vegetation and under loose stones. It may be easily recognized by its small size, subcylindrical form, thin texture and pale horn color. The animal is pale yellow.

PARTULA, Ferussac.

P. Actor, Albers.

Partulus actor, Albers, Die Hel., p. 187.

Partula actor, Chem. ed. 2d., pl. 48, figs. 13, 14. Pfeiffer, Mon. Hel., iii, p. 450. Hartman, Cat. Part., p. 12; Obs. Gen. Part. Bull. Mus. Comp. Zool., p. 179; Proc. Acad. Nat. Sci. Phila., 1885, p. 220.

Partula Recluziana, Petit, Jour. de Conch., 1850, p. 170, pl. 7, fig. 5. Pfeiffer, Mon. Hel., iii, p. 452. Mousson, Jour. de Conch., 1869, p. 339. Paetel, Cat. Conch., p. 104. Schmeltz, Cat. Mus. Godeff., v, p. 91.

Partula zebrina, Gould, Proc. Bost. Soc. Nat. Hist., 1848. p. 196; Exp. Exp. Shells, p. 82, fig. 89. Pfeiffer, Mon. Hel., iii., p. 450.

This species, which is unknown to me, inhabits Tutuila. It may be distinguished by its ovate-conical form, whitish or pale fulvous color, ornamented with more or less flexuous paler lines. Length 19 mill.

P. expansa, Pease.

Partula expansa, Pease, Amer. Jour. Conch., 1871, p. 26, pl. 9, fig. 3; Proc. Zool. Soc., 1871, p. 473 (*extensa* in err.). Pfeiffer, Mon. Hel., viii, p. 203. Hartman. Cat. Part., p. 13; Obs. Gen. Part., Bul. Mus. Comp. Zool., p. 182; Proc. Acad. Nat. Sci. Phila., 1885, p. 212.

Partula zebrina, Mousson (not of Gould), Jour. de Conch., 1865, p. 173, 1869, p. 339.

This charming species, which is not uncommon on foliage at Upolu, may be distinguished by its white color and spiral opaque-white interrupted lines. The spire is moderately produced, the last whorl ventricose, obliquely produced and the base exhibits a large umbilicus. The peristome is broadly and flatly expanded. Length 19 mill.

Mr. Pease, on the authority of Mr. Brazier cites Tutuila as its habitat.

P. canalis, Mousson.

Partula canalis, Mousson, Jour. de Conch., 1865, p. 172; 1869, p. 337 (var. *semilineata*). Pfeiffer, Mon. Hel., vi, p. 155. Pease, Proc. Zool. Soc., 1871, p. 473. Paetel, Cat. Mus. Godeff., v, p. 91,

Partula Bulimoides, Hartman (not of Lesson), Cat. Gen. Part., pp., 12, 13 with wood cut; Obs. Gen. Part. Mus. Comp. Zool., p. 180.

Partula cornica, Gould (part), Proc. Bost. Soc. Nat. Hist., 1847, p. 196. Hartman, Proc. Acad. Nat. Sci. Phila., 1885, p. 222.

Not infrequent on foliage at Upolu. The variety was found by Dr. Gräffe at Tutuila.

A fine large sinistral species, 29 mill. long. elongate conical in shape, of a fulvous-brown color with darker tinted spire. Aperture large; peristome whitish, broadly expanded, slightly reflexed and a deep transverse sulcation marks the upper part of the columella lip.

The fine spiral incised lines which are very distinct on the whole surface of *P. conica* are only visible on the boundaries of the open umbilicus and on the apical whorls.

P. abbreviata, Mousson.

Partula abbreviata, Mousson, Jour. de Conch., 1869, p. 339, pl. 14, fig. 7. Pease, Proc. Zool. Soc., 1871, p. 473. Paetel, Cat. Conch., p. 104. Schmeltz Cat. Mus. Godeff., v, p. 91. Pfeiffer, Mon. Hel., viii, p. 200. Hartman, Cat. Gen. Part., p. 13; Obs. Gen. Part., Bul. Mus. Comp. Zool., p. 179.

This fine species which is unknown to me was found at Tutuila by Dr. Gräffe.

An ovate, thin, pale horn colored species closely allied to but much more abbreviated than *P. conica.* Prof. Mousson says it is intermediate between the latter species and *P. canalis.* Length 21 mill.

P. conica, Gould.

Partula conica, Gould, Proc. Bost. Soc. Nat. Hist., 1847, p. 196; Expl. Exp. Shells, p. 81. Pfeiffer, Mon. Hel., iii, p. 445. Mousson, Jour. de Conch., 1865, p. 171. Pease, Proc. Zool. Soc., 1871, p. 473. Paetel, Cat. Conch., p. 104. Schmeltz, Cat. Mus. Godeff., v, p. 91. Hartman, Proc. Acad. Nat. Sci. Phila., 1885, p. 222.

Partula Upolensis, "Mousson" Schmeltz, Cat. Mus. Godeff., no. 1. Paetel, Cat. Conch., p. 104.

Partula Bulimoides, Hartman (not of Lesson), Cat. Gen. Part: p. 12; Obs. Gen. Part. Bul. Mus. Comp. Zool., p. 108.

Not uncommon on foliage at Upolu and Tutuila.

A dextral oblong-conical, luteous-horn colored species, smaller than the sinistral *P. canalis*, with five convex whorls and rather large aperture. Lip white and broadly expanded. Length 23 to 24 mill.

P. Brazieri, Pease.

Partula Brazieri, Pease, Amer. Jour. Conch., 1871, p. 27, pl. 9, fig. 5; Proc. Zool. Soc., 1871, p. 473. Pfeiffer, Mon. Hel. viii, p. 194.

"Tutuila" (Brazier).

Mr. Pease received a single example of this species from Mr. Brazier who says it was the only specimen found at the above mentioned locality.

Dr. Hartman, who has examined the type specimen in the Museum of the Philadelphia Academy, refers it to the synonomy of *P. Caledonica* a New Hebrides species. Judging from the figure of *Brazieri* it certainly has a strong resemblance to the New Hebrides *Partula*. I doubt it having been obtained at Tutuila.

TORNATELLINA, Beck.

T. oblonga, Pease.

Tornatellina oblonga, Pease, Proc. Zool. Soc., 1864, p. 673; 1871, p. 473; Jour. de Conch., 1871, p. 93. Pfeiffer, Mon. Hel., vi, p. 264. Schmeltz, Cat. Mus. Godeff., v, p. 89. Garrett, Proc. Phil. Acad. Nat. Sci., 1879, p. 21; Jour. Phil. Acad. Nat. Sci., 1881, p. 398.

Tornatellina bacillaris, Mousson, Jour. de Conch., 1871, p. 16, pl. 3, fig. 5. Schmeltz, Cat. Mus. Godeff., v, pp. 89, 90. Pfeiffer, Mon. Hel. viii, p. 316.

Stenogyra (Subulina) bacillaris, Paetel, Cat. Conch., p. 104.

Inhabits all the groups from the Paumotu to the Viti Islands, and was found by Dr. Gräffe on the low coral islands of the Ellice's group in "Central Pacific." On the ground in forests.

This species may be distinguished by its imperforated base, slender form, thin pellucid texture, fuscous-horn color, 6 whorls, and nearly vertical simple columella. Length 4½ mill.

T. conica, Mousson.

Tornatellina conica, Mousson, Jour. de Conch., 1869, p. 342, pl. 14, fig. 8; 1871 (var. *impressa*), p. 16. Pease, Proc. Zool. Soc., 1861, p. 473. Pfeiffer, Mon. Hel., viii, p. 316. Garrett, Proc. Phil. Acad. Nat. Sci., 1879, p. 21; Jour. Phil. Acad. Nat. Sci., 1881, p. 399; 1884, p. 81, Schmeltz, Cat. Mus. Godeff., v, p. 89.

Cionella conica, Paetel, Cat. Conch. p. 116.

Has the same range and station as the preceding species.

It is more robust and lighter colored than *oblonga*, the spire more tapering, body-whorl larger, more compressed, parietal laminæ more prominent and the columella more twisted than in that species.

SUCCINEA, Draparnaud.

S. putamen, Gould.

Succinea putamen, Gould, Proc. Bost. Soc. Nat. Hist., 1846, p. 183; Exp. Exp. Shells, p. 13, fig. 16. Pfeiffer, Mus. Hel., ii, p. 522. Mousson, Jour. de Conch., 1865, p. 174; (*Amphibulima*) 1869, p. 343. Pease, Proc. Zool. Soc., 1871, p. 472. (*Amphibulima*) Paetel, Cat. Conch., p. 113. Schmeltz, Cat. Mus. Godeff., v, p. 89.

Omalonyx putamen, H. and A. Adams, Gen. Moll., ii, p. 131.

Common on foliage at Upolu.

This fine large species may be distinguished by its depressed ovate form, thin texture, fulvous-horn color, very short spire, 1½ whorls, the last one with irregular, interrupted impressed striæ. Aperture very large, roundly-ovate, and the columella subplicated. Length 17, Diam. 12½ mill.

S. crocata, Gould.

Succinea crocata, Gould, Proc. Bost. Soc. Nat. Hist., 1846, p. 183; Exp. Exp. Shells, p. 28, fig. 21. Pfeiffer, Mon. Hel., ii, p. 520. Mousson, Jour. de Conch., 1865, p. 174; (*Amphibulima*) 1869, p. 343. H. and A. Adams, Gen. Moll., ii, p. 128. Paetel, Cat. Conch., p. 113. Pease, Proc. Zool. Soc., 1871, p. 472. Schmeltz, Cat. Mus. Godeff., v, p. 89.

Abundant at Upolu.

A large species of a rather thin texture, ovate-globose form, fulvous-horn color, 2½ whorls, the last one very large, usually with revolving impressed lines. Spire short. Length 19, diam. 13 mill.

S. modesta, Gould.

Succinea modesta, Gould, Proc. Bost. Soc. Nat. Hist., 1846, p. 186; Exp. Exp. Shells, p. 23, fig. 24. Pfeiffer, Mon. Hel., ii, p. 521, Mousson, Jour. de Conch., 1865, p. 174; (*Amphibulima*) 1869, p. 343. H. and A. Adams, Gen. Moll., ii, p. 129. Pease, Proc. Zool. Soc., 1871, p. 472. (*Brachyspira*) Paetel, Cat. Conch., p. 113. Schmeltz, Cat. Mus. Godeff., v, p. 89

Succinea Cheynei, Dohrn, MS.

I found this species abundant on the ground in a forest at Upolu. Its small size (9 mill. long), ovate form, thin texture, luteous-horn color, moderate spire, and 3 whorls will readily distinguish it.

S. Manua, Gould.

Succinea Manua, Gould, Proc. Bost. Soc. Nat. Hist., 1846, p. 185; Exp. Exp. Shells, p. 25, fig. 23. Pfeiffer, Mon. Hel., ii, p. 520. H. and A. Adams, Gen. Moll., ii, p. 129. Pease, Proc. Zool. Soc., 1871, p. 472.

Said to inhabit Manua Island.

Gould says it is a small, ovate, ventricose, thin, straw-colored species, with an obtuse spire, 2½ whorls, deep suture and marked by longitudinal striæ and transverse rugosities. Length 10 mill.

VERTIGO, Müller.

V. pediculus, Shuttleworth.

Pupa pediculus, Shuttleworth, Bern. Mitth. 1852, p. 296. Pfeiffer, Mon. Hel., iii, p. 557. Schmeltz, Cat. Mus. Godeff., v. 89. Mousson (var. *Samoensis*), Jour. de Conch., 1865, p. 175.

Vertigo pediculus, Pfeiffer, Vers., p. 177. (*Alæa*) H. and A. Adams, Gen. Moll., ii, p. 172. Mousson, Jour. de Conch., 1869, p. 341. Pease, Proc. Zool. Soc., 1871, pp. 463, 474. Garrett, Proc. Phil. Acad. Nat. Sci., 1879, p. 19; Jour. Phil. Acad. Nat. Sci., 1881, p. 400.

Pupa Samoensis, "Mss." Schmeltz, Cat. Mus. Godeff., iv. p. 108. (*Sphyradium*) Paetel, Cat. Conch. p. 108.

Pupa nitens, Pease, Proc. Zool. Soc., 1860, p. 439. Pfeiffer, Mon. Hel., vi, p. 335.

Vertigo nitens, Pease, Proc. Zool. Soc., 1871, pp. 463, 474.

Pupa hyalina, "Zelebor," Pfeiffer. Mon. Hel., vi, p. 329.

Vertigo hyalina, Pease, Proc. Zool. Soc., 1871, p. 474.

Vertigo nacca, Gould, Proc. Bost. Soc., Nat. Hist., 1862, p. 280; Otia Conch., p. 237, Pease, Proc. Zool. Soc., 1871, pp. 463, 474.

Pupa nacca, Pfeiffer, Mon. Hel., vi, p. 330.

Common to all the Polynesian groups.

Its minute size, ovate-oblong shape, hyaline texture, obtuse spire, rounded aperture, and the thin slightly expanded lip will readily distinguish it. There are usually 5 denticles in the aperture.

V. tantilla, Gould.

Pupa (Vertigo) tantilla, Gould, Proc. Bost. Soc. Nat. Hist., 1847, p. 197, Pfeiffer, Mon. Hel., iii, p. 557. (*Vertigo*) Mousson, Jour. de Conch., 1870, p. 127. (*Vertigo*) Schmeltz, Cat. Mus. Godeff., iv, p. 69. (*Pupinella*) Paetel, Cat. Conch., p. 108.

Vertigo tantilla, Gould, Exp. Exp. Shells, p. 92, fig. 103. (*Alæa*) H. and A. Adams, Gen. Moll., iii, p. 172. Pease. Proc. Zool. Soc., 1871, pp. 460, 463, 474. Garrett, Jour. Phil. Acad. Nat. Sci., 1881, p. 400.

Pupa pleurophora, Shuttleworth, Bern. Mittheil., 1852, p. 296. Pfeiffer, Mon. Hel., iii, p. 560.

Vertigo pleurophora, Pease, Proc. Zool. Soc., 1871, p. 474.

Pupa Dunkeri, "Zelebor" Pfeiffer, Mon. Hel., vi, p. 333.

Vertigo Dunkeri, Pease, Proc. Zool. Soc., 1871, p. 474.

Vertigo armata, Pease, Proc. Zool. Soc., 1871, pp. 461, 474.

Pupa armata, Pfeiffer, Mon. Hel., viii, p. 407.

Vertigo dentifera, Pease, Proc. Zool. Soc., 1871, pp. 462, 474.

Pupa dentifera, Pfeiffer, Mon. Hel., viii, p. 408.

Ranges from the Society to the Viti Islands. This and the preceding species are found beneath rotten wood, under stones and amongst decaying leaves.

In shape it varies from an abbreviate-ovate to oblong-oval, and they vary to a greater or less degree in the relative proportion of the whorls. Color pale corneous under a brownish more or less distinctly shagreened epidermis, which in perfect examples is furnished with oblique membranous riblets. The last whorl behind the peristome is frequently bisulcate.

MELAMPUS, Montfort.

M. luteus, Quoy and Gaimard.

Auricula lutea, Quoy and Gaimard, Voy. Astrol., ii, p. 163, pl. 6, figs. 25-27. Deshayes, Lam. Hist., viii., p. 338. Kuster, Auric., p. 39, pl. 6, figs. 1-3. Mousson, Jav. Moll.. p. 47, pl. 5, fig. 6.

Conovulus luteus, Anton, Verz., p. 48.

Melampus luteus, Beck, Ind., p. 106. M. E. Gray, Figs. Moll. Anim., pl. 306, fig. 5, H. and A. Adams, Proc. Zool. Soc., 1854, p.

10; Gen. Moll., ii, p. 243. Pfeiffer, Syn. Auric., no. 30; Mon. Auric. i, p. 36. Mörch, Cat. Yold., p. 38. Mousson, Jour. de Conch., 1869, p. 346. Martens and Langk. Don. Bism., p. 55. Gassies, Faun. Nouv. Caled., p. 62. Pease, Jour. de Conch., 1871, p. 93; Proc. Zool. Soc., 1871, p. 477. Paetel, Cat. Conch., p. 114. Schmeltz, Cat. Mus. Godeff., v, p. 88. Garrett, Proc. Phil. Acad. Nat. Sci., 1879, p. 28. Jour. Phil. Acad. Nat. Sci., 1881, p. 402.

Abundant just above high-water mark and ranges from the Gambier Islands to the East Indies.

This species may be easily recognized by its large size (18 mill.) and uniform luteous color.

M. fasciatus, Deshayes.

Auricula fasciata, Deshayes, Encycl. Meth., ii, p. 90; Lam. Hist., viii, p. 337. Kuster, Auric., pl. a, figs. 2, 3. Mousson, Jav. Moll., p. 46, pl. 5, figs. 28-29.

Melampus fasciatus, Beck, Ind. Moll., p. 107. (*Tralia*) H. and A. Adams, Proc. Zool. Soc., 1854, p. ii. Pfeiffer, Syn. Auric., no. 33; Mon. Auric., i, p. 38. Mousson, Jour. de Conch., 1869, p. 348. Pease, Proc. Zool. Soc., 1871, p. 477. Martens and Langk., Don. Bism., p. 55. Paetel, Cat. Conch., p. 114. Schmeltz, Cat. Mus. Godeff., v, p. 88. Garrett, Jour. Phil. Acad. Nat. Sci., 1881, p. 402.

Conovulus fasciatus, Griffith, Cuv. Anim. King., pl. 27, fig. 13. Anton, Verz., pl. 48. Guerin, Icon. Moll., pl. 17, pl. 7, fig. 8.

Tralia (Pira) fasciata, H. and A. Adams, Gen. Moll., ii, p. 240.

Auricula trifasciata, Kuster, Auric., p. 38, pl. 5, figs. 15-17.

Melampus trifasciatus, Pfeiffer, Syn. Aurica., no. 38; Mon. Auric., i, p. 43, H. and A. Adams, Gen. Moll., ii, p. 243. Gassies, Faun. Nouv. Caled., p. 63, Cox, "Exchange List," p. 33. Brazier, Quar. Jour. Conch., i, p. 274.

Auricula monile, Quoy and Gaimard, Voy. Astrol., ii, p. 166, pl. 13, figs. 28-33. Potiez and Michaud, Gal. Douai., i, p. 208. Reeve, Conch. Syst., ii, pl. 187, fig. 8.

Cassidula ? monile, M. E. Gray, Figs. Moll. Anim., p. 306, figs. 10-11. (Ex. Q. and G.)

This, like the preceding species lives just above high-water mark and has the same extensive geographical range.

It is subject to considerable variation in form, color and fasciation. The type varies from bluish-white to luteous and girdled by four to six narrow chestnut bands. Varieties of a uniform bluish-white, corneous, brownish or orange-brown are not infrequent, as well as

one of an orange-brown with three chestnut bands. The spire is marked with minute radiating grooves which are very faintly expressed or very conspicuous, sometimes covering the whole spire or only visible at the apex. Length 11 to 14 mill.

M. parvulus, Nuttall.

Melampus parvulus, Nuttall, MS., Pfeiffer, Syn. Auric., no. 11; Mon. Auric., p. 24. H. and A. Adams, Gen. Moll., ii, p. 243. Pease, Proc. Zool. Soc., 1871, p. 477. Martens and Langk. Don. Bism., p. 56, pl. 3. fig. 10. Paetel, Cat. Conch., p. 114. Brazier, Quar. Jour. Conch., i, p. 247.

Common on the margins of mangrove swamps. Also common in the Tonga and Viti Islands. Mr. Nuttall obtained the type specimens at the Sandwich Islands. It not only inhabits New Caledonia but ranges west as far as Torres' Strait, where it was found by Mr. Brazier.

The Samoa specimens which are a little smaller than Nuttall's type, differ none from the latter except having one or two more denticles or plicæ on the parietal region, and the base is more distinctly, impressly striated, It may be recognized by its ovate shape, smooth shining surface, dark-chestnut, or olive brown color, short convexly conoid spire and mucronated apex. On the lower portion of the parietal region may be observed two approximating folds, the lower one the smaller and occasionally wanting. There are usually one or two small denticles above, and the palate has 5 to 7 laminæ. The columellar fold is continuous with the basal portion of the peristome. Length 7-9 mill.

M. Tongaensis, Mousson.

Melampus Tongaensis, Mousson, Jour. de Conch., 1871, p. 22, pl. 3, fig. 8. Schmeltz, Cat. Mus. Godeff., v, p. 88. Pfeiffer, Mon. Pneum. (Auric.), iv, p. 316.

A few examples found in the same station as the preceding species. Common also in the Tonga and Viti Islands.

Very closely allied to, and perhaps only a form of *M. parvulus.* It is about the same size and color, but is a little more oblong and the spire is more produced. The fold and dentition is the same in the two species.

M. semisulcatus, Mousson.

Melampus semisulcatus, Mousson, Jour. de Conch., 1869, p. 347, pl. 15, fig. 2, Paetel, Cat. Conch., p. 114. Schmeltz, Cat. Mus. Godeff.,

v, p. 88. Pfeiffer, Mon. Pneum. (Auric.), iv, p. 318. Pease, Proc. Zool. Soc., 1871, p. 477.

Common on the margins of mangrove swamps. Occurs also in the Tonga and Viti Islands.

This species is of an oblong pear-shape, uniform cinnamon color, spire short, usually eroded, spirally grooved, the grooves more or less evanescent on the middle of the body-whorl. There are three folds on the parietal region and usually two laminæ in the palate. Length 11 mill.

M. striatus, Pease.

Melampus striatus, Pease, Proc. Zool. Soc., 1861, p. 244; 1871, p. 477. Pfeiffer, Mon. Pneum. (Auric.), iv, p. 311. Schmeltz, Cat. Mus. Godeff., v, p. 88.

Melampus Montrouzieri, Souverbie, Jour. de Conch., 1866, p. 148, pl. 6, fig. 1, 1a. Pfeiffer, Mon. Pneum. (Auric.), iv, p. 312.

Melampus ornatus, Mousson, Jour. de Conch., 1871, p. 21, pl. 3, fig. 7. Pfeiffer, Mon. Pneum. (Auric.), iv, p. 312.

A few examples found on the margins of swamps at Upolu. It also inhabits the Society, Tonga and Viti Islands as well as New Caledonia.

It may be distinguished by its oblong-ovate form, brownish-corneous, chestnut-brown or greenish-brown color, mucronated spire, 8 whorls, marked by closely-set transverse impressed lines, and the upper half with small longitudinal plications which give that part of the shell a granulated appearance. The transverse lines are frequently evanescent on the middle of the body-whorl. There are from two to three folds on the parietal region, the upper one small and granuliform. There may be observed one to three lamelliform plications in the palate, and, sometimes with several raised white parallel striæ. Length 9-10 mill.

M. castaneus, Muhlfeld.

Voluta castanea, Muhlfeld, Mag. Ges. Nat. Fr. Berl., vii, 1818, p. 4, pl. 1, fig. 2.

Auricula castanea, Philippi, Zeits. Malak. 1851, p. 54.

Melampus castaneus, Pfeiffer, Mon. Auric., p. 30. Mousson, Jour. de Conch., 1869, p. 349.

Prof. Mousson records this species in his Samoan list. It did not occur to my notice.

LAIMODONTA, Nuttall.

L. Layardi, H. and A. Adams.

Ophicardelus Layardi (*Laimodonta*), H. and A. Adams, Proc. Zool. Soc., 1854, p. 35.

Laimodonta Layardi, H. and A. Adams, Gen. Moll., ii, p. 246.

Melampus Layardi, Pfeiffer, Syn. Auric., no. 48; Mon. Auric., p. 51. Gassies, Faun. Nouv. Caled., p. 61, pl. 7, fig. 7. Tennent's Ceylon, i, p. 239. Cox, "Exchange List," p. 33. H. Nevill, Enum. Hel. etc., Ceylon, 1871, p. 4.

Laimodonta conica, Pease, Proc. Zool. Soc., 1862, p. 242; Amer. Jour. Conch., 1868, p. 101, pl. 12, fig. 15; Jour. de Conch., 1871, pp. 93, 94. Proc, Zool. Soc., 1871. pp. 470, 477. Schmeltz, Cat. Mus. Godeff., v, p. 81. Garrett, Jour. Phil. Acad. Nat. Sci., 1881, p. 403.

Laemodonta conica, Martens and Langk., Don. Bism., p. 57, pl. 3, fig. 13.

Laimodonta Anaaensis, Mousson, Jour. de Conch., 1869, p. 63. pl. 5, fig. 1.

Plecotrema Anaaensis, Paetel, Cat. Conch., p. 114.

Melampus conicus, Pfeiffer, Mon. Pneum. (Auric.), iv, p. 319.

"?" *Melampus Anaaensis*, Pfeiffer, l. c., p. 320.

A few beach-worn specimens found at Upolu. Ranges from the Paumotu Islands to the East Indies.

This species is acuminately-ovate, rather solid, spirally striated by incised lines, spire rather long, acute; color chestnut-brown, with one or two transverse whitish bands. Parietal region with two plaits, one on the columella and one or two in the palate.

Length 6 to 8½ mill.

CASSIDULA, Ferussac.

C. crassiuscula, Mousson.

Cassidula crassiuscula, Mousson, Jour. de Conch., 1869, p. 343, pl. 15, fig. 1. Paetel, Cat. Conch., p. 114. Pease, Proc. Zool. Soc., 1871, p. 477. Schmeltz, Cat. Mus. Godeff., v, p. 88. Pfeiffer, Mon. Pneum. (Auric.), iv, p. 352.

Auricula (*Cassidula*) *crassiuscula*, Mousson, Jour. de Conch., 1871, p. 191.

Cassidula nucleus, Gassies, (Martyn ?), Faun. Nouv. Caled., p. 71, pl. 3, fig. 9.

Common on the mud in mangrove swamps, and inhabits the Tonga, Viti and the islands in Melanesia.

A thick, broadly ovate, imperforate species, with fine spiral impressed striæ and short conical spire. Color different shades of chestnut-brown, white, corneous, fulvous, frequently with from one to four transverse bands on the body-whorl, and more rarely with a sutural livid band. Aperture pale fulvous, brownish or white, and the lip light fulvous or white. Length 10 to 16 mill.

C. paludosa, Garrett.

Ophicardelus paludosus, Garrett, Amer. Jour. Conch., 1872, p. 220, pl. 19, fig. 3.

Cassidula paludosa, Paetel, Cat. Conch., p. 114.

Plecotrema paludosa, Schmeltz, Cat. Mus. Godeff., v, p. 87.

Melampus paludosus, Pfeiffer, Mon. Pneum. (Auric.), iv, p. 327.

A few specimens found in mangrove swamps at Upolu. Common in the Viti group.

A small, solid, ovate, whitish, yellowish-horn colored, or chestnut-brown species, with fine, spiral, incised punctured lines and carinated base. Spire convexly conical and more produced than in the preceding species. Length 8 to 10 mill.

PYTHIA, Bolten.

P. tortuosa, Mousson.

Pythia tortuosa, Mousson, Jour. de Conch., 1871, p. 19, pl. 3, fig. 6. Paetel, Cat. Conch., p. 114. Schmeltz, Cat. Mus. Godeff., v, p. 87. Pfeiffer, Mon. Pneum. (Auric.), iv, p. 339. Nevill, List. Moll. Ind. Mus., p. 221. Cox, Proc. Lin. Soc. N. S. W., 1881, p. 618.

Common on the margins of mangrove swamps at Upolu. Dr. Gräffe collected examples at Futuna and Wallis Island in the northern part of the Tonga group.

This species which ranges from 18 to 25 mill. in length, is luteous horn-color, with small irregular chestnut-brown maculations; sometimes uniform chestnut-black or corneous, and the varices are spotted with dark chestnut and white. The base is either imperforated or rimate. The aperture is luteous, rarely brownish, and the peristome is usually mottled. The columellar fold is generally continuous with the basal portion of the peristome, and the lower parietal plait is simple.

P. Savaiensis, Mousson.

Pythia pantherina, A. Adams, var. *Uveana*, Mousson, Jour. de Conch., 1865, p. 177. Schmeltz, Cat. Mus. Godeff., iii, p. 28. Pease, Proc. Zool. Soc., 1871, p. 477. Paetal, Cat. Conch., p. 114. Pfeiffer,

Mon. Pneum. (Auric.), iv, p. 348. Cox, Proc. Lin. Soc., N. S. W., 1881, p. 607.

Pythia Savaiensis, Mousson, Jour. de Conch., 1869, p. 345; 1870, p. 133. Pease, Proc. Zool. Soc., 1871, p. 477. Schmeltz, Cat. Mus. Godeff., v, p. 87. Pfeiffer, Mon. Pneum. (Auric.), iv, p. 341. Cox. Proc. Lin. Soc. N. S. W., 1881, p. 613. Nevill, List, Moll. Ind. Mus. p. 223.

This species was found at Savaii by Dr. Gräffe. I gathered numerous examples at Wallis Island and in the Viti group. In forests near the sea-shore.

A solid, ovate, umbilicated (rarely imperforate), species 21 to 28 mill. long, of a corneous or yellowish-horn color, mottled with chestnut, rarely uniform light or dark chestnut and the varices spotted with white. Aperture luteous.

A larger and more solid shell than the preceding species.

AURICULA, Lamarck.

A. subula, Quoy and Gaimard.

Auricula subula, Quoy and Gaimard, Voy. Astrol., ii, p. 171, pl. 13, figs. 39, 40. Deshayes, Lam. Hist., viii, p. 334. Kuster, Auric., p. 53, pl. 8, figs. 9, 10. Jay, Cat. Shells, 1850, p. 265. A. Adams and Reeve, Voy. Samarang, p. 55, pl. 14, fig. 15, with animal. Pfeiffer, Auric., no. 147; Mon. Auric., i, p. 141. Gassies, Faun. Nouv. Caled., p. 69. Paetel, Cat. Conch., p. 115.

Pythia subula, Beck, Ind. Moll., p. 104.

Ellobium subula, H. and A. Adams, Proc. Zool. Soc., 1854, p. 8. Gen. Moll., ii, p. 237.

Auricula elongata, "Parreyss" Kuster, Auric., p. 53, pl. 8, figs. 6-9. Jay, Cat. Shells, 1850, p. 264. Pfeiffer, Auric., no. 146; Mon. Auric., i, p. 140. Morelet, Ser. Conch., p. 93. Mousson, Jour. de Conch., 1871, p. 18. Paetel, Cat. Conch., p. 115. Schmeltz, Cat. Mus. Godeff., v, p. 88.

Auricula Buddii, Parreyss, MS.

Ellobium elongatum, H. and. A. Adams, Proc. Zool. Soc., 1854, p. 9; Gen. Moll., ii, p. 237.

Ellobium Oparicum, H. and A. Adams, Proc. Zool. Soc., 1854, p. 9; Gen. Moll., ii, p. 237.

Auricula Oparica, Pfeiffer, Mon. Auric., i p. 139; Syn. Auric., no. 46; Novit. Conch., i, p. 28, pl. 7, figs. 14-16.

Auriculus subulus, Pfeiffer, Mon. Pneum. (Auric.), iv, p. 360.

Auriculus elongatus, Pfeiffer, l. c.

Ariculus Oparicus, Pfeiffer, l. c.

A few small examples found on the margin of a swamp at Upolu. It occurs in the Tonga and Viti Islands and ranges west as far as the East Indies. Morelet records it from the island of Mauritius.

A small species, 9 to 16 mill. long, of a slender fusiform shape, smooth, shining surface, acute conical spire (which is frequently truncated by erosion); color white beneath an epidermis which varies from pale olivaceous-horn color to chestnut-black. The body whorl is narrow, usually longer than the spire, attenuated or rounded at the base, and the columella is furnished with two, small, approximating, oblique folds. A compressed subtransverse plait on the lower part of the parietal region.

S. semisculpta, H. and A. Adams.

Ellobium semisculptum, H. and A. Adams, Proc. Zool. Soc., 1854, p. 9; Gen. Moll., ii, p. 237.

Auricula semisculpta, Pfeiffer, Syn. Auric., no. 139; Mon. Auric., i, p. 136; Novit, Conch., i, p. 39. pl. 10, figs. 7-9. Gassies, Faun. Nouv. Caled., p. 70, pl. 3, fig. 11. Schmeltz, Cat. Mus. Godeff., v, p. 88.

Auriculus semisculptus, Pfeiffer, Mon. Pneum. (Auric.), iv, p. 359.

A few dead specimens of small size found on the margin of a mangrove swamp at Upolu. It is also common at Wallis Island and very abundant and of large size at the Viti group, where they were found buried in rotten logs in swamps.

This species varies considerably in shape, thickness, and in size, ranging from 12 to 30 mill. in length. The surface is shining, longitudinally striated, and the upper portions of the whorls are sculptured by crowded spiral rows of minute granules, which, in the adult sometimes cover the whole surface of the body-whorl. The shape of the shell varies from oblong-ovate to oblong-turreted, the spire more or less produced, and the color is white beneath a fulvous-yellow or yellowish-horn colored epidermis. The parietal region exhibits a prominent, compressed, oblique fold and just beneath is a smaller and more vertical one on the columella.

TRUNCATELLA, Risso.

T. valida, Pfeiffer.

Truncatella valida, Pfeiffer, Zeit. Malak., 1846, p. 182; Mon. Auric., (appendix), i, p. 184. Jay, Cat. Shells, 1854, p. 253. Kuster, Mon., p. 11, pl. 2, figs. 7, 8, 19-21, 23. H. and A. Adams, Gen. Moll.,

ii, p. 311. Martens, Ostas. Zool., ii, p. 262. Paetel, Cat. Conch., p. 118. Pease, Proc. Zool. Soc., 1871, p. 477.

Truncatella Vitiana, Gould, Proc. Bost. Soc. Nat. Hist., 1847, p. 208; Exp. Exp. Shells, p. 109, fig. 126; Otia, Conch., p. 40. H. and A. Adams, Gen. Moll., ii, p. 6. Mousson, Jour. de Conch., 1869, p. 356; 1870, p. 195. Paetel, Cat. Conch., p. 118. Schmeltz, Cat. Mus. Godeff., v, p. 104.

Truncatella Vitiacea, Mousson, Jour. de Conch., 1865, p. 185.

Taheitia Vitiana, Pease, Proc. Zool. Soc., 1871, p. 477.

Truncatella conspicua, "Bronn," Pfeiffer, Mon. Auric. (appendix), i, p. 184. Paetel, Cat. Conch., p. 118. Layard, Cat. Land and Fresh-water Shells, N. Caled., p. 1.

Common just above high-water mark in sheltered places. It occurs also in Tonga, Ellis and Viti groups, and is diffused throughout Melanesia and the East India Islands.

A solid, slightly tapering, cylindrical shell, of a white, luteous, corneous, or ruddy corneous color, with 4½ slightly convex persistent whorls. The sculpture consists of nearly erect, obtuse ribs (25 to 35), on the body whorl. Peristome slightly auriculate at the suture. Length 6 to 8 mill.

MOUSSONIA, O. Semper.

M. typica, O. Semper.

Pupa problematica, Mousson, Jour. de Conch., 1865, p. 176.

Moussonia typica, O. Semper, Jour. de Conch., 1865, p. 296. Crosse, Jour. de Conch., 1866, p. 354, pl. 10, fig. 9. Pease, Proc. Zool. Soc., 1871, p. 476. Paetel, Cat. Conch., p. 118. Schmeltz, Cat. Mus. Godeff., v, p. 102.

Paxillus (*Moussonia*) *typica*, Mousson, Jour. de Conch., 1869, p. 355.

Diplommatina problematica (*Moussonia*), Stoliczka, Jour. Asiat. Soc., 1871, p. 156. (*Moussonia*), Pfeiffer, Mon. Pneum. iv, p. 92.

A minute conical, dark colored species with turreted spire, 7 obliquely costulate whorls and small, rounded aperture and a columella tooth.

Found at Upolu by Dr. Gräffe.

OSTODES, Gould.

O. tiara. Gould.

Cyclostoma tiara, Gould, Proc. Bost. Soc. Nat. Hist., 1847, p. 204; Exp. Exp. Shells, p. 101, fig. 116.

Cyclophorus tiara, Pfeiffer, Consp. Cyclos., no. 116; Mon. Pneum., i, p. 84. Gray, Cat. Phan., p. 58. Mousson, Jour. de Conch., 1865, p. 179; (*Ostodes*) 1869, p. 350. Paetel, Cat. Conch., p. 120.

Ostodes tiara, Gould, Proc. Bost. Soc. Nat. Hist., 1862, p. 240. Pease, Proc. Zool. Soc., 1871, p. 475.

Not uncommon at Upolu, where it was found at an altitude of "1.000 metres" by Dr. Gräffe.

Its large size (18 to 20 mill. in diam.), depressed turbinate form, dull greyish-horn color beneath a luteous, or horn-colored epidermis, 5 convex whorls, the last one subcarinated, and the fine spiral lirations will readily distinguish it.

O. strigatus, Gould.

Cyclostoma strigatum, Gould, Proc. Bost. Soc. Nat. Hist., 1847, p. 204; Exp. Exp. Shells, p. 102, fig. 117. Chemn. ed. 2d. p. 302, pl. 40, figs. 15, 16.

Cyclophorus strigatus, Pfeiffer, Consp. Cyclos., no. 115; Mon. Pneum., i, p. 83. Gray, Cat. Phan., p. 58. H. and A. Adams, Gen. Moll., ii, p. 280. Reeve, Conch. Icon., pl. 14, fig. 58. Mousson, Jour. de Conch., 1865, p. 179; (*Ostodes*), 1869, p. 350. Paetel, Cat. Conch., p. 120. Schmeltz, Cat. Mus. Godeff., v, p. 99.

Ostodes strigatus, Gould, Proc. Bost. Soc. Nat. Hist. 1861, p. 283.

Cyclostoma plicatum, Gould, Proc. Bost. Soc. Nat. Hist., 1847, p. 205; Exp. Exp. Shells, p. 103, fig. 118.

Cyclophorus plicatus, Pfeiffer, Consp. Cyclos., no. 114; Mon. Pneum., iv, p. 115. Reeve, Conch. Icon., pl., 14, fig. 58. (*Ostodes*) Mousson, Jour. de Conch., 1869, p. 350.

Ostodes plicatus, Gould, Proc. Bost. Soc. Nat. Hist., 1861, p. 283. Pease, Proc. Zool. Soc., 1871, p. 475.

Cyclostoma Apiæ, Recluz, Jour. de Conch., 1851, p. 213, pl. 6, figs. 10, 10.

Cyclophorus Apiæ. Pfeiffer, Mon. Pneum., i, p. 83. Gray, Cat. Phan., p. 57. H. and A. Adams, Gen. Moll., ii, p. 279. Paetel, Cat. Conch., p. 119.

Cyclostoma pulverulentum, Philippi, Chemnitz, ed. 2d. p. 301, pl. 40, figs. 13, 14.

Cyclophorus pulverulentus, Pfeiffer, Consp. Cyclos., no. 114.

Cyclostoma albida, Hombron and Jacquinot, Voy. Pol. Sud. Zool., v, p. 50, pl. 12, figs. 25-28.

Cyclophorus ? albidus, Pfeiffer, Mon. Pneum., ii, p. 60.

Abundant beneath decaying vegetation at Upolu, Tutuila and Savaii.

This variable species may be recognized by its rude solid texture, more or less globose form, cinereous, or ruddy-horn color, 5 convex whorls, the last one rounded and more or less distinctly angulated on the margin of the moderate umbilicus. The sculpture consists of spiral, irregular, elevated lines which are frequently evanescent on the last whorl, and in the form known as *plicatus*, Gld., have the whorls transversely obliquely plicated. The spire is more or less elevated. The diameter varies from 8 to 12 mill.

O. Upolensis, Mousson.

Cyclophorus Upolensis, Mousson, Jour. de Conch., 1865, p. 180; (*Ostodes*) 1869, p. 352. Paetel, Cat. Conch., p. 120. Pfeiffer, Mon. Pneum., iv, p. 115. Schmeltz, Cat. Mus. Godeff., v, p. 99.

Ostodes Upolensis, Pease, Proc. Zool. Soc., 1871, p. 475.

Common beneath decaying vegetation at Upolu.

A small, thin, whitish, depressed, conoid species with 4½ convex whorls. the last one rounded or slightly angulated, and all with spiral elevated lines; sometimes the whorls are rudely plicated. The umbilicus is large and the margin is angulated.

Diam. 7½ mill.

O. adjunctus, Mousson.

Cyclophorus (*Ostodes*) *adjunctus*, Mousson, Jour. de Conch., 1869, p. 351, pl. 14, fig. 9. Pfeiffer, Mon. Pneum., iv, p. 114.

Ostodes adjunctus, Pease, Proc. Zool. Soc., 1871, p. 475.

Found at Tutuila by Dr. Gräffe.

This species is widely umbilicated, rather solid, depressly-conical, whitish, with 4½ slightly convex whorls, the last one carinated, and all with spiral elevated lines. Diam. 9 mill.

O. ? Brazieri, Cox.

Cyclostoma Brazieri, Cox, Proc. Zool. Soc., 1870, p. 85.

Cyclotus ? Brazieri, Pfeiffer, Mon. Pneum., iv, p. 36.

This species, which is unknown to me, was found by Mr, Brazier at Upolu.

The following is Cox's description as given by Mr. Pfeiffer:—

"Testa pyramidata; spira acuta et elevata, apice rosea, anfr. 5, rotundati, sub lente subtilissima spiraliter striati; saturate cinnamomia; sutura profunda; umbilicus augustus et profundus; aper-

tura circularis; perist. simplex vix incrassatum. Operculum solidum extus perconcavum, marginibus anfractuum prominentibus.

Lat. 0.13, alt. 16 poll."

Genus OMPHALOTROPIS, Pfeiffer.

O. conidea, Mousson.

Omphalotropis conoidea, Mousson, Jour. de Conch., 1865, p. 182. Pease. Jour. de Conch., 1869, p. 146; Proc. Zool. Soc., 1871, p. 476. Paetel, Cat. Conch., p. 124. Schmeltz, Cat. Mus. Godeff., v, p. 101.

Realia (*Omphalotropis*) *conoidea,* Mousson, Jour. de Conch., 1869, p. 353 (et var. *angulosa*); 1871, p. 27. Pfeiffer, Mon. Pneum., iv, p. 222.

I am not acquainted with this species, which was found at Upolu by Dr. Gräffe, and the variety at Savaii. He found it also at Wallis Island.

An ovate conical species, 7 mill. long, with 6½ rather flattened whorls, the last one large, ovately-rounded, perforated, and the perforation margined by a filiform keel. Moussson says "*epidermide subdestituta, punctis et lineis fulguratis saepe reticularis malleata.*" In his remarks (Jour. de Conch., 1869, p. 146) he says "Les jeunes individus, d'un rouge grisâtre et peu fulgurés, sont, en effet, parfaitement lisses; mais bientôt on découvre des points d'une coloration blanchâtre et mate, qui interrompent les parties polies et se disposent en lignes anguleuses, qui finissent par dominer à l'âge ou l' épiderme est entirèment détruit."

His variety *angulata* has the last whorl angular.

O. bilirata, Mousson.

Omphalotropis bilirata, Mousson, Jour. de Conch., 1865, p. 184, pl. 14, fig. 13. Pease, Jour. de Conch., 1869, p. 146; Proc. Zool. Soc., 1871, p. 476.

Realia (*Omphalotropis*) *bilirata,* Mousson, Jour. de Conch., 1869, p. 146 (var. *elongata*); 1871, p. 29. Pfeiffer, Mon. Pneum., iv, p. 218.

More rare than the preceding species and inhabits Upolu and Savaii, as well as Wallis Island in the Tonga group.

A perforated, elongate-conical, pale corneous species with an incised sutural line which is margined above with a filiform keel. Whorls 6, flattened, the last one angulated and bicarinated with a periphery and basal thread-like keel. Length 5½ mill.

O. bifilaris, Mousson.

Omphalotropis bifilaris, Mousson, Jour. de Conch., 1865, p. 183. Pease, Jour. de Conch., 1869, p. 146; Proc, Zool. Soc., 1871, p. 476. Paetel, Cat. Conch., p. 124. Schmeltz, Cat. Mus. Godeff., v, p. 101.

Realia (*Omphalotropis*) *bifilaris*, Mousson, Jour. de Conch., 1869, p. 353 (var. *angusta*); 1871, p. 29. Pfeiffer, Mon. Pneum., iv, p. 232.

Not infrequent at Upolu and Tutuila; found also at the Tonga group. Mousson's variety *angusta* which inhabits the Viti Islands is probably a distinct species.

The type is a perforated, conical shell, 6¾ mill. long, with a fugaceous fuscous epidermis and rounded whorls, the last one with a periphery and basal filiform keel.

HELICINA., Lamarck.

H. fulgora, Gould.

Helicina fulgora, Gould, Proc. Bost. Soc. Nat. Hist., 1847, p. 201; Exp. Exp. Shells, p. 95, fig. 106. Pfeiffer, Mon. Pneum., i. p. 401. Gray, Cat. Phan., p. 293. H. and A. Adams, Gen. Moll., ii, p. 302; Mousson, Jour. de Conch., 1865, p. 178; 1869, p. 356; 1870, p. 198 (var. *expansa*); 1871, p. 25 (var. *diminuta*). Pease, Proc. Zool. Soc., 1871, p. 476. Paetel, Cat. Conch., p. 125. Schmeltz, Cat. Mus. Godeff.. v, p. 98 (var. *delicatula*).

Helicina delicatula, "Mss." Paetel, Cat. Conch., p. 125.

Abundant beneath decaying vegetation and is diffused throughout the group. The variety *delicatula* is common at Samoa, and Mousson's *diminuta* is widely spread over the Tonga group. Variety *expansa* inhabits Kanathia, one of the Viti Islands.

This variable species may be recognized by its conoid form, thin texture, oblique striation, yellowish horn-color and radiating angular or flexuous rufous strigations. Sometimes the stripes are interrupted so as to form a series of spots along the sutural line and on the acutely carinated periphery. The peristome is slightly expanded and forms an angle at its junction with the short columella.

Diam. 4 to 9 mill.

H. plicatilis, Mousson.

Helicina plicatilis, Mousson, Jour. de Conch., 1865, p. 178; 1869, p. 358. Pease, Proc. Zool. Soc., 1871, p. 476. Paetel, Cat. Conch., p. 126. Brazier, Proc. Zool. Soc., 1871, p. 322. Schmeltz, Cat. Mus. Godeff., v, p. 98. Pfeiffer, Mon. Reunion, iv, p. 251.

Common on trees at Upolu.

A large, solid, white, depressly conical species, with 4½ depressed whorls, the last one wide, obtusely angular, or bluntly carinated on the periphery. The peristome is sharp, and in adult individuals the anterior margin of the basal cellosity forms a crest-like ridge which joins the base of the outer-lip. Diam. 9 mill.

Mr. Brazier (in P. Z. S.. 1871, p. 322), says Mousson's *plicatilis* is synonymous with Pfeiffer's *H. Norfolkensis*, and that Cuming's locality "Norfolk Island" is erroneous. Though the species has several years precedence in publication, and, if they are identical, Mr. Brazier is fully justified in rejecting Pfeiffer's name which is a misnomer.

The description of *Norfolkensis* agrees very nearly with the Samoa shell, but no mention is made of the peculiar crest-like basal ridge. The measurements are too large for the latter species.

H. beryllina, Gould.

Helicina beryllina, Gould, Proc. Bost. Soc. Nat. Hist., 1847, p. 202; Exp. Exp. Shells, p. 95, fig. 111. Pfeiffer, Mon. Pneum., i, p. 354. Gray, Cat. Phan., p. 256. (*Idesa*) H. and A. Adams, Gen. Moll., ii, p. 304. Mousson, Jour. de Conch., 1865, p. 197; 1869, p. 357 (var. *flavida*); 1870, p. 200. Paetel, Cat. Conch., p. 125. Pease, Proc. Zool. Soc., 1871, p. 476. Schmeltz, Cat. Mus. Godeff., v, p. 98.

Gould's typical *beryllina* inhabits the eastern portion of the Viti Islands, and Mousson's var. *flavida* was found at Tutuila by Dr. Gräffe. The latter variety has the spire and base yellowish, the last whorl whitish with a yellowish zone. In every other respect it differs none from the Vitian type, which is a large species (9 to 10 mill. in diam.), of a solid texture, depressly conoid in shape and rather variable in color: white, greenish-white, flesh-color, frequently with a dorsal red zone. Lip simple and the periphery obtuse.

H. interna, Mousson.

Helicina interna, Mousson, Jour. de Conch., 1869, p. 358; 1870, p. 201, pl. 8, fig. 6; 1871, p. 24. Paetel, Cat. Conch., p. 125. Schmeltz, Cat. Mus. Godeff., v, p. 99. Pfeiffer. Mon. Pneum., iv, p. 248. Pease, Proc. Zool. Soc., 1871, p. 476.

This species, which is common to the Viti and Tonga Islands, was found by Dr. Gräffe at Savaii.

A turbinately conical species of a uniform white, or yellowish color, with or without a spiral reddish-brown zone and regular coni-

cal spire. Whorls 5, slightly convex, the last one rounded or obtusely angulated. Peristome acute. Diam. 9 mill.

H. musiva, Gould.

Helicina musiva, Gould, Proc. Bost. Soc. Nat. Hist., 1847, p. 201; Expl. Exp. Shells, p. 98, fig. 107. Pfeiffer, Mon. Pneum., i, p. 368. Gray, Cat. Phan., p. 259. H. and A. Adams, Gen. Moll., ii, p. 302. Mousson, Jour. de Conch., 1865, p. 178 (var. *Uveana*); 1869, p. 357; 1870, p. 202 (vars. *Vitiana et subcarinata*); 1871, p. 25; 1873, p. 107 (var. *rotundata*). Pease, Proc. Zool. Soc., 1871, p. 476. Paetel, Cat. Conch., p. 125 (*musica* in err.).

This variable species is abundant beneath decaying vegetation on the lowlands near the sea-shore. It is also common in the Tonga and Viti Islands as well as in the low coral islands of Ellis group.

The shape varies from depressed globose to sub-lenticular, and, in size varies from 3 to 5 mill. in diameter. The usual color is white, corneous, or pale yellowish horn-color with radiating reddish-chestnut more or less zigzagged or undulating stripes, rarely unicolor. The periphery is rounded, or subangulated and the peristome slightly expanded.

H. altivaga, Mousson.

Helicina altivaga, "Mousson" Schmeltz, Cat. Mus. Godeff., v, p. 99.

This species, which was neither described nor figured, was found at Upolu, by Dr. Gräffe.

ASSIMINEA, Leach.

A. nitida, Pease.

Hydrocena nitida, Pease, Proc. Zool. Soc., 1864, p. 674.

Assiminea nitida, Pease, Jour. de Conch., 1869, p. 165, pl. 7, fig. 11; Proc. Zool. Soc., 1871, p. 476. Schmeltz, Cat. Mus. Godeff., v, p. 103. Garrett, Proc. Phil. Acad. Nat. Sci., 1879, p. 29; Jour. Phil. Acad. Nat. Sci., 1881, p. 408.

? *Realia nitida*, Pfeiffer, Mon. Pneum., iii, p. 202.

Hydrocena parvula, Mousson, Jour. de Conch., 1865, p. 184; 1873, p. 108.

Omphalotropis parvula, Pease, Jour. de Conch., 1869, p. 155; Proc. Zool. Soc., 1871, p. 476. Paetel, Cat. Conch., p. 124.

Assiminea parvula, Pease, Proc. Zool, Soc., 1871, p. 476. Schmeltz, Cat. Mus. Godeff., v, p. 103.

Realia parvula, Pfeiffer, Mon. Pneum., iii, p. 213.

Assiminea lucida, Pease, Jour. de Conch., 1869, p. 166, pl. 7, fig. 10; Proc. Zool. Soc., 1871, p. 476.

Assiminea ovata, "Pease" Schmeltz, Cat. Mus. Godeff., v, p. 103.

Hydrocena pygmæa, Gassies, Jour. de Conch., 1867, p. 63.

Assiminea pygmæa, Pease, Jour. de Conch., 1869, p. 165.

? *Realia pygmæa*, Pfeiffer, Mon. Pneum., iv, p. 214.

Hydrocena similis, Baird, in Cruise of the Curacoa.

This species is distributed throughout all the groups from the Paumotu's to the Viti Islands and New Caledonia. They are found beneath decaying leaves, under stones and dead wood.

It may be recognized by its small size (2½ to 4 mill. long), smooth, shining surface, ovate-conical form, light or dark corneous color; rarely with a faint transverse band on the last whorl.

MAY 3.

Mr. THOS. MEEHAN, Vice-President, in the chair.

Twenty-three persons present.

On Aphyllon as a root Parasite.—Mr. Thomas Meehan remarked that the life histories of many of our root parasites were still obscure,–in many cases we hardly knew whether they were annual or perennial; how long it took for them to perfect themselves, and in some cases it was even doubted whether they were parasites in the true sense of the word, or merely obtained a start by feeding on partially decomposed vegetable matter. In one of the earlier editions of *Flora Cestrica*, Dr. Wm. Darlington observes that he has often dug *Aphyllon uniflorum* without finding it attached to anything,—and, though he omits this remark in later editions, he observes that it is "*Perennial?*" The speaker remarked that he had dug this species very carefully when in bloom, and washed the earth gently away, finding them truly parasitic on the coarser fibres of Asters and Goldenrods. They very readily separate from their connection unless carefully handled, which may account for the failure to note their true parasitic nature.

A specimen sent by Mr. Morris, a florist of Des Moines Iowa, of an allied species *A. fasciculatum* Torr. and G., (*Phelipæa fasciculata* of some authors), gives the opportunity for acquiring certain knowledge in relation to these points. Mr. Morris raised numerous plants of the common bedding geranium (*Pelargonium zonale*). The cuttings were made in October and November last. They were potted in earth taken from a piece of newly cleared woodland in the vicinity. The plants appeared in many of the geranium pots in his greenhouse, and were in full flower in April. As the plants were only in this soil for about three months, the seeds must have sprouted, flowered, and were on the decline in that time. They are therefore annual, and a very short-lived annual at that.

In regard to the parasitism, the attachment in several that Mr. Meehan had examined, was to the coarser roots. In the plant exhibited, it was to the main stem of the cuttings beneath the ground, and not to the roots, which in this specimen were merely weak fibres.

The geranium, an African plant, and of a very different character from these which the *Aphyllon* has been in the habit of feeding on, proving so acceptable to it in this instance, shows that it is either not partial in its parasitic tastes, or that it has ready powers of adaptation when something suited to its peculiar habits comes along.

MAY 10.

The President, Dr. JOSEPH LEIDY, in the chair.

Twenty persons present.

The following was presented for publication:—

"Contributions towards a Synopsis of the American forms of Fresh-Water Sponges with Descriptions of those named by other authors and from all parts of the world.," By Edw. Potts.

The death of Robert H. Hare, a member, was announced.

On the Stipules of Magnolia Frazeri.—Mr. Thomas Meehan exhibited some fresh flowers of *Magnolia Frazeri*, Walter—(*M. auriculata*, Lamarck), and said that when he contributed the paper on the "Stipules of Magnolia and Liriodendron" to the Proceedings of the Academy in 1870, he had not had the opportunity to examine fresh flowers of this species. It was not common in cultivation from the fact that the plants grown rarely produced seeds, and there had been little opportunities to get seeds from its North Carolina home. On his grounds of late years a specimen had annually borne flowers, which appeared very early, following immediately the flowers of the Yulan, and were as large and sweet as that species of China.

A point made in the paper referred to was that the petals of *Magnolia* were not modified leaves, as the petals of flowers would be broadly stated to be in morphological works but rather modified stipules, in which case the petiole and leaf blade have wholly aborted. At the time of its appearance, Dr. Asa Gray, to whose kindly criticisms on this and other papers he had been so often deeply indebted, wrote expressing his interest in the paper, saying that the observations confirmed the views of some German observer, whose name he could not recall, that the petals of many flowers were but modified stipules.

Mr. Meehan had not been able to meet with the name of the author or of the paper referred to by Dr. Gray, or the tenor of the author's views. Indeed his observations and those of the author referred to, must have been wholly overlooked by their co-laborers, or else the views have not commended themselves to their good judgment. For his own part the subsequent observations of nearly twenty years had convinced him that the petals of most flowers should be considered enlarged stipules or thinly dilated bases of petioles, rather than modified leaves, as we should understand this term. In many species of Roses, especially in *Rosa Kamtchatica*, and *Rosa cinnamomea* the stipules could be noted increasing, and the size of the leaf blade diminishing on the branch as it approached inflorescence. Often the tips of the sepals would develop to minute leaf blades, and in a few instances he had had seen the same appendages on abnormal petals. Often the stipules, especially in *Rosa Kamtchatica*, would have the red colors of the petals, when at the nodes immediately below the axis from which the peduncle proceeded. There could be no possible doubt in the minds of those who would carefully compare, and watch for occasional aberrations, that the petals of the rose were rather transformed stipules than complete leaves. Precisely the same process of development from stipules to

petals could be traced in some *Leguminosæ*, and especially in the common Red Field Clover.

When vegetation was arrested in its growth and bud scales were formed for the protection of the growth-germ for the next season, it was the stipule or dilated base of the petiole that formed the scale. This was evident to those who watched the bursting of the growth buds in spring of the species of *Fraxinus*, or of the Dwarf Horse Chestnut (*Aesculus parviflora*) common in gardens.

The formation of petals for the protection of the reproductive germ, was also the result of arrested vegetative growth, and we may safely assume that the same law operates on the stipules and petiolar bases, in the one case as in the other.

This *Magnolia* confirms these views, as already indicated in the paper referred to. The stipules increase in size, and the development of the leaf blade is arrested just in proportion as the true petals are approached, until the last one preceding the true flower is nearly as large as the petals, and of nearly their form and character. In some cases the stipule appears as a perfect petal, with not a of leaf blade left. The true sepal or petal has lost all trace of petiole or blade,—it is broadened at the base, and, we see, cannot be aught but the stipule modified.

The fact that the petals of flowers are rather the bases of petioles or stipules, than modifications of full typical leaves may not only be proved by such observations as have been referred to, but accords with that philosophy which would expect to find an uniform law result from uniform causes. For if, as cannot be doubted, the check vegetative growth produce petal a bud scale out of a stipule, the check to vegetative growth should produce a petal (a flower scale) out of the same typical form. The theory gives to morphological law a harmony of action that is wanting without it.

May 17.

Mr. J. H. Redfield, in the chair.

Twenty-eight persons present.

May 24.

Mr. Chas. Morris, in the chair.

Twenty-nine persons present.

A paper entitled "Notes on the Anatomy of Echidna hystrix." By H. C. Chapman M. D., was presented for publication.

Permission was given to change the name of a communication presented October 19, 1886, by Prof. Wm. B. Scott, for publication in the Journal of the Academy, from "The Genera Mesonyx and Pachyaena, Cope." to "On some new and little-known Creodonts."

MAY 31.

The President, Dr. JOSEPH LEIDY, in the chair.

Twelve persons present.

Asplanchna Ebbesbornii.—Dr. Leidy remarked that a few days ago Mr. Wm. P. Seal, had submitted to him a four ounce bottle swarming with animalcules, which at first glance he supposed to be a species of *Cypris*, but on closer inspection he observed to be a rotifer. As seen with the naked eye they appeared transparent whitish, and of conical shape and about half a line in length. They swam actively, with the crown uppermost, and at all levels of the water. The rotifer accords closely with the description of *Asplanchna Ebbesbornii*, given by Hudson in the Journal of the Royal Microscopical Society in 1883, p. 621, pl. ix, x. As in this it has a dorsal and ventral projection. At times it was observed that the rotifer would retract the crown and project a pair of lateral conical horns, when it would appear as broad as it was long. The stomach is yellowish and suspended from the pharynx by a long narrow œsophagus. There was a single eye. The animal is viviparous, and was observed in a number of instances to suddenly give birth to a young one which was about two thirds the size of the parent. and resembled it in form. Specimens measured from ¾ to 1½ mm in length. Mr. Hudson's specimens were obtained from a duck-pond in Wiltshire, England, the only known locality. Mr. Seal's specimens were obtained from a "filthy sewage-fed pond,—a duck-pond and hog-wallow" below the city. In summer it is completely covered with duck weed, *Lemna*. The water swarms with the rotifer in company with *Daphnia*. Mr. Seal remarks that he noticed sand pipers about the place and thinks these birds are especially instrumental in distributing the lower forms of aquatic life.

The following were elected correspondents:—

Henry A. Ward of Rochester, Addison E. Verrill of New Haven, R. P. Whitfield of New York, Edgar A. Smith of London, August Brot of Geneva, E. Ray Lankester of London, William E. Hoyle of Edinburgh, Eduard von Martens of Berlin, William Kobelt of Schwanheim, S. Clessin of Ochsenfurt, Rev. M. Heude, S. J. of Zika-Wei, China, Rudolph Bergh of Copenhagen, A. T. de Rochebrune of Paris and Herrman Friele of Bergen.

The following were ordered to be printed:—

CONTRIBUTIONS TOWARDS A SYNOPSIS OF THE AMERICAN FORMS OF FRESH WATER SPONGES WITH DESCRIPTIONS OF THOSE NAMED BY OTHER AUTHORS AND FROM ALL PARTS OF THE WORLD.

BY EDWARD POTTS.

Dr. Bowerbank's "Monograph of the Spongillidæ," (Proc. Zool. Soc., London, 1863 p. 440 etc.) and "The History and Classification of the known species of Spongilla," by H. J. Carter Esq. F. R. S. etc. (Annals and Mag. of Nat. Hist., London, 1881, p. 77 etc.) contain the only complete synopses of the fresh water sponges, as known at their respective dates. Both writers have, in their introductory remarks, given full information as to the history and bibliography of this branch of study, which it cannot be necessary now to repeat.

My design in the preparation of the present paper has been, primarily, to describe those genera and species, mostly North American, that have been discovered since the date of Mr. Carter's publication; next, to detail the results of a somewhat extended examination into the character and variations, in North America, of those species that have long been familiarly known in Europe; and thirdly, to make it valuable for reference as a Monograph, by adding brief technical descriptions of all other "good" species.

A further purpose, and one that I hold much at heart, is the desire to revive, among scientists and lovers of nature, an appreciation of the apparently almost forgotten fact of the existence of sponges in our fresh water; to show them that they are easily found and collected; that they are deeply interesting as living subjects of study, microscopic and otherwise; and that, by simple processes, their typical parts may readily be prepared for classification and the permanent preservation of their various singular forms. With this end in view the situations and conditions in which the American species were found, have been briefly described, suggesting the hopefulness of an exploration of similar localities in other neighborhoods.

During the last six or seven years the leisure time of a very busy life has been largely occupied in the collection and examination of sponge material. In this labor of love I have been greatly aided by the contributions and correspondence of friends, till then unknown, in widely separated districts, for whose thoughtful kindness

I now desire to express my indebtedness. It were idle to attempt to name them all; but to Professors Allen, Cope, Hunt, Leidy and Heilprin of Philadelphia, to Dawson, Hyatt, Bumpus and Osborn in other localities, I am particularly indebted. As active workers in the same field and during nearly the same period, I am glad to acknowledge my constant obligation to my friends Mr. Henry Mills, of Buffalo, N. Y. and Mr. B. W. Thomas of Chicago, Ill., whose names will frequently be found throughout the following pages. More recently my valued friend and correspondent Mr. A. H. MacKay, of Pictou, Nova Scotia, has been untiring in his efforts, very successful in his local and New Foundland collections and most generous in the contribution of his valuable material. I owe to my friend Prof. John A. Ryder of the University of Pennsylvania, what has been of more value than any material, the most unfailing courtesy and the best of advice, assistance and encouragement to persevere in my work. From abroad I have been honored with the correspondence and publications of Dr. W. Dybowski of Niankow, Russia, Prof. Marshall of Leipsig, Vejdovsky and Petr of Prague, Bohemia. Prof. Vejdovsky has laid me under especial obligations by his repeated gifts of Bohemian and other European sponges, besides his "Diagnosis of the European Spongillidae" now published as a very valuable contribution to this paper. I thank Dr. C. W. de Lannoy, late of Chester, Pennsylvania, for the original drawings for plates V aud VI the excellence of which will be conceded by all acquainted with the subjects.

Two names remain of friends, without whose influence and assistance this Monograph would probably never have been written. The first has passed the alloted term of "three score years and ten," and now, with failing strength, but unfailing love of his work, is hastening to garner the last ripe sheaves of a life of honorable scientific labor. I count it a great privilege to have become acquainted, near the beginning of my work, with H. J. Carter, Esq. of Devonshire, England, than whom no obscure scientist could hope for a more constant friend or more courteous correspondent. To the fine artistic skill and unwearying patience of the other, Miss S. G. Foulke of Philadelphia, my readers, with myself, owe a large part of the value of this work, in the admirable drawings from which plates VII to XII have been reproduced.

These reproductions are the work of the Photo-Engraving Co. (N. Y.) and while it is regretted that from the very nature of the

process no photo-engraved plate could repeat, with their relative delicacy, the finer lines of Miss Foulke's beautiful drawings, in other respects they are very well done.

A few words of elementary information may be desirable to aid those who for the first time undertake the study of sponges.

In constitution and general appearence the fresh water sponges resemble many of those of a marine habitat, excepting in one particular. This crucial point is the presence, during certain resting seasons, in most of the former, and the absence from *all* the latter, of those "seed-like bodies" that have been known and described by various authors under the names of ovaria, gemmules, statoblasts, statospheres, sphærulæ, etc. In the past I have generally avoided the use of the familiar word statoblast, as it did not seem clearly proven that the function of these "seed like bodies" of the sponges was identical with that of the statoblasts of the polyzoa etc; and have used the terms statospheres, or sphærulæ, as suggesting merely their general appearance. Latterly, however, I have concurred with several European writers in the use of the old term, gemmules; the principal objection to which, is that with some persons the name may seem like a return to the exploded vegetable theory of sponges. It is hardly necessary to say that this idea is not intended.

In shape these gemmules are nearly spherical; they are about $\frac{1}{50}$ of an inch in diameter, or as large as very small mustard seeds. They are found sometimes in continuous layers, as at the base of encrusting sponges; sometimes they rest singly in the interspaces among the skeleton spicules; again, they occur in groups of a dozen or less, sparsely scattered through the sponge mass, or in smaller, denser groups, closely enveloped in a compact cellular parenchyma. Their principal coat, presumably of chitin, encloses a compact mass of protoplasmic globules, each of which is charged with numbers of discoidal particles, whose function, though all important, it is not my intention to discuss in the present paper. A circular orifice, rarely more than one, through this chitinous coat, sometimes, though inaptly called the hilum, should be known as the foramen or foraminal aperture. Through it, at the time of germination, the above mentioned protoplasmic bodies make their exit, crawling by an amœboid movement, and spreading out on every side. In a few hours the infant colony may be seen producing aqueous currents,

developing and arranging skeleton spicules, and in every way living the life of a young sponge. The foraminal aperture is rarely plain; more frequently it is infundibular, (Pl. V, fig. i, a,), having a slightly raised and expanded margin; while in still other species it is prolonged into cylindrical or funnel shaped tubules (Pl. VI, fig. iii, iv, and v.)

In most species, possibly in all under normal conditions, the chitinous coat is surrounded by a "crust" (Pl. VI, figs. i, ii, etc.), composed of air cells, often so minute as to be with difficulty "resolvable," even with a high power of the microscope; in other species so large as to be readily discerned by the use of a low one. In the first instance it has been called a "granular," in the other, a "cellular" "crust." In this are imbedded (Pl. V and VI,), the spicules which, as will be hereafter seen, are relied upon to determine the generic classification of these sponges.

To recur for a moment to the resemblance stated to exist between the fresh water and *some* of the marine sponges,—we can see no obvious reason why *all* the marine forms should not have their representatives among those belonging to fresh water; but it is a fact that all of the latter, as yet discovered, are *silicious;*—that is, the skeleton or framework, (corresponding to the elastic fibre of which commercial sponges are composed) upon which the slime-like sponge flesh, known as "sarcode," is supported, and through whose interstices the currents meander, is composed of silicious spicules, slightly bound together by an almost invisible quantity of firmer sarcode or perhaps of colloidal silica.

To form the main lines of this skeleton structure the spicules, averaging about $\frac{1}{100}$th. of an inch in length, are fasciculated in bands made up of several spicules, lying side by side, and somewhat overlapping at their extremities; the crossing lines being formed of more slender fascicles, or even of single spicules. In the different species these "skeleton" spicules vary in size, in the shape of their terminations, and in their more or less spinous character (see Plates VII to XII, a,a,); but while these differences serve, in some degree, as specific guides, they are not sufficiently constant or positive to form a basis for generic arrangement.

Besides the skeleton spicules, a second class, known as "dermal" or flesh spicules (Pl. VII to XII, c, d, e, etc.) is found only in some species and in greater or less numbers, either lying upon the outer "dermal" film or lining the canals in the deeper portions of the sponge. They

are almost always much smaller than those of the skeleton and are never fasciculated or bound together in any way. A third class of spicules is composed of those before mentioned as imbedded in the "crust" of the gemmules, and form what may be regarded as their armor or defensive coating. These gemmule-spicules represent two principal and several subordinate types, which have been selected by Mr. Carter to define the different genera into which he has divided the single genus *Spongilla* of the earlier authors. His method of classification will be given later.

The sponge in its entirety as a growing organism can generally be easily recognized by the collector, after he has escaped from the thraldom of the idea that any fixed growth, of a more or less vivid green color, must be a *plant* of some kind. Of course the mosses and confervæ will be rejected after examination, upon the evidence given by the leaves of the one and the smooth slender threads of the other. If doubts remain as to any specimen, the presence in it of efferent or discharging apertures, like those of the commercial sponge, if it is really a sponge, may serve to dispel them, and still more convincing proof will be given by the use of a pocket lens, in detecting the points of multitudinous spicules thickly studding the surface. When, in addition to these guiding features, the spherical gemmules just described are found within or under it, there should be no further hesitation.

The green color spoken of, is common and characteristic; yet it is not universal, but closely dependent upon the quantity or quality of the light received. When a sponge has germinated away from the light and has grown upon the lower side of a plank or stone, it will be found nearly white, gray or cream colored. As it enlarges and creeps around the edge and up into the full sun light it assumes a delicate shade of green, deepening as the exposure increases, till it attains a bright vegetable hue. Even in the sunlight, however, some species are never green. (See description of *Meyenia leidyi.*)

These organisms have occasionally been discovered growing in water unfit for domestic uses; but as a rule they prefer pure water, and in my experience the finest specimens have always been found where they were subjected to the most rapid currents. The lower side of large, loose stones at the "riffs" or shallow places in streams; the rocks amid the foaming water at the foot of a mill-dam fall; the timbers of a sluice-way, the casing of a turbine waterwheel, or the walls of a "tail race" beneath an old mill;—in all these places

they have been found in great abundance and of a very lusty growth. Of all discouraging situations it is almost hopeless to look for them in shallow water having a mud bottom. Mud is their great enemy, as gravity aids their natural currents to fill the cavities with earthy matters that soon suffocate them, because the latter are too feeble to throw them off. Of course in any body of water liable to be charged with sedimentary material, the principle of natural selection favors those growing on the lower side of their bases of support, which protect them from the intrusion of the heavier particles.

For that reason perpendicular and water logged or floating timbers, submerged stumps of trees, and branches drooping into the water from trees or bushes along the banks, are favorite locations. They do not disdain more temporary support, such as weeds and water-grasses. I have received from a friend, specimens growing upon water plants that wild ducks had torn from the bottom, and that were found floating upon the surface of Lake Michigan. Through the clear water of our northern lakes, we may often see them lying in slender lines upon the leaves of submerged weeds, or in beautiful cushion-like masses upon the stones or gravel.

In my explorations I have had much satisfaction in the use of a long pole, to which was attached a small net, with one part of its edge shaped into a scraper, like a garden hoe. This enabled me to examine the surface of timbers at a depth of eight or ten feet and to tear off and bring up sponges from that depth; beyond which all is to me an "aqua incognita." Biologists labor at some disadvantage in studying the fauna of our fresh water, as compared with the facilities offered them in collecting ocean subjects. The nets and dredges of many exploring expeditions have, at least, *begun* to acquaint us with the inhabitants of the "deep sea;" but who knows anything about the fauna or the flora of our deep fresh-water lakes, or even of our larger streams? The largest specimens of this group ever reported, were dredged from the bottom of Lake Baikal in Central Asia, (*Lubomirskia*). I know of no similar attempts to collect them elsewhere. It is to be hoped that means may be found ere long to make such explorations, which must result in an increase of knowledge in many lines. Meantime no opportunity offered by the accidental or designed drainage of artificial reservoirs should be neglected. I have spent hours of great pleasure and profit while groping around the distributing reservoirs upon Fairmount Hill, Philadelphia, at times when the water was drawn off for cleaning or repairs.

One further point as to methods of collecting and I shall finish this section of my subject. Unless our sponges are large, it is difficult to detach them without mutilation, from the rough surfaces of stones. It is therefore preferable to gather, when possible, those growing upon wood, which may be scraped or chipped without injury to them. It is essential to secure the very lowest portions, as it is there the gemmules often abide.

The proper season for collecting fresh water sponges, in waters of the temperate zone, depends upon the purpose of the collector. If it is his desire to gather cabinet specimens merely, for the identification of old or the determination of novel species, it is hardly worth while to begin before July. As with the flowering of plants, the maturity of different species of sponges is attained at various dates, between mid-summer and late in November. The essential point is, that the gemmules and their armature shall be fully perfected; and when that condition is attained in any specimen, there is no reason for further delay.

I would, however, recommend to intending students a far higher object for their ambition;—that is, the study of the physiology and life history of sponges as members of a sub-kingdom whose position has been greatly questioned and whose character, derivation and subsequent evolution are very important and perplexing topics. I would have such workers search for and examine them at all seasons of the year, (even in midwinter, when I have never failed in suitable situations to find some in a growing condition), keeping memoranda as to each species separately; noting the date of their germination or earliest appearance, the locality, elevation, temperature; rapidity of growth at different seasons; time and manner of formation of gemmules; stability or decadence during the winter; modes of distribution and progression, whether always down stream or by other more adventitious methods; what becomes of the gemmules upon reaching salt-water, and the thousand and one problems that go to make up the life history of any animal form, and that, in this instance, have been very little studied. I am particularly anxious that some competent person should undertake their study in the briny, brackish and the fresh water lakes, pertaining to what is known as the "Great Basin of the West," with a special view to ascertain the conditions under which they form "protected gemmules" in such localities. By this means, light may possibly be thrown upon the problem of their possible derivation from the marine sponges.

Great pleasure and profit may be attained in the same direction, by germinating the statoblasts or gemmules under artificial conditions, and studying the development of the young sponges by the aid of as high powers of the microscope as the ingenuity of each student may bring to bear upon the subject. I take the liberty to copy from the Ann. and Mag. Nat. Hist. 1882, p. 365, Mr. Carter's directions for germinating statoblasts, which will be found valuable. "To obtain the young spongillæ it is only necessary to get a portion of an old living specimen bearing statoblasts, and, having taken out a few (six to twelve) of the latter, to roll them gently between the folds of a towel to free them from all extra material as much as possible, place them in a watch glass so as not to touch each other, with a little water, in a saucer or small dish filled with small shot to keep the saucer upright and, covering them with a glass shade, transfer the whole to a window bench opposite to the light. In a few days the young *Spongilla* may be observed (from its white color) issuing from the statoblast and gluing the latter as well as itself to the watch glass, when it will be ready for transfer to the field of the microscope for examination, care being taken that it is never uncovered by the water, which may be replenished as often as necessary; but of course the object-glass (when ¼ inch with high occular is used for viewing the minute structure) must admit of being dipped into the water without suffusion of the lens."

My own first experience in the propagation of fresh water sponges may prove instructive in various ways. Late in the autumn of the year 1879, in a pond within the "Centennial Grounds," Philadelphia, I found for the first time a living sponge. It was a vigorous, branching specimen of *Spongilla lacustris*, charged with gemmules in all parts of its structure. A fragment firmly attached to a stone was taken home and placed in a gallon "specie-jar" with water, in the hope, begotten of inexperience, that it would continue to grow, exhibit its inflowing and exhalent currents, etc. On the contrary, and as I now know, almost necessarily, it died, and in a few days the water became insupportably foul. It was changed and another trial made, which resulted as before. This time the jar was thoroughly cleansed; the stone with the attached sponge was taken out and held long under a flowing hydrant before it was replaced in the jar, which was now left in an outer shed and, very naturally, forgotten. Weeks passed and winter came on, and one severe night the water in my jar was frozen solid and the vessel fractured. I supposed

that the low temperature to which it had been subjected would prove fatal to the germs, but, as the specimen was a fine one, it seemed well to save it, even in its skeletonized condition. So, when its icy envelope had been melted off, the sponge was again thoroughly washed until all the sarcode was removed, when, in a fresh jar, it again became a parlor specimen.

I do not clearly remember when signs of germination were first observed. It was probably in January, as during that month I find that artificial conditions very frequently bring about the hatching of such animal germs as those of the polyzoa etc. I detected first a filmy, grayish-white growth that seemed associated with the detached gemmules which lay in the groove around the bottom of the jar. A gray, featureless growth at first,—then spicules were seen, in slightly fasciculated lines, attached to the glass and reaching upward, then spreading out fan-like and branching. These were of course, covered with sarcode, nearly transparent at first, and through the filmy surface pores and osteoles could be detected with a pocket lens. The latter were surmounted by the so-called "chimneys" or cone-shaped extensions of the dermal film; and through the apertures at their summits effete particles could almost constantly be seen, puffed out, as if thrown from a volcano and then blown off by the wind.

These products of single gemmules did not, as time passed on, greatly increase in size; possibly, because of deficient nutriment in the unchanged water of the jar: but, crawling upward along the glass to an average height of an inch or less, left the naked spicules in place behind them as so many ladders or "stepping stones of their dead selves" by which they had reached to "higher things." Near the summit, one or more new gemmules would sometimes be formed, after which the mother mass entirely disappeared.

So much for the amount of growth from single gemmules. Where, however, they were thickly sown, or germinated *in situ* upon the stone, so that the contents of several could mingle and flow together, the resultant sponge was very much larger. The mass, if it may be so called, covered, at its best, nearly one third the surface of the jar; while those gemmules remaining upon the stone and amongst the spicules of the old sponge, continued to germinate, to form abundant sarcode and spicules, and, at least in one place, to throw out a long unsupported branch or finger-like process, that ultimately reached a length of two or three inches.

Of course it was impossible to bring the higher powers of a com-

pound microscope to bear upon a sponge growing under such circumstances; a strong Coddington lens was the best that could be applied to this work; but a very fair share of success was obtained by the device of scattering small squares of mica among the growing gemmules, which, when covered by the young sponge, could be removed to the stage of my instrument, covered with water in a compressorium and examined comparatively at leisure. It was a perpetual cause of astonishment to me, to see so large a production of silicious spicules from a single gallon of water, in which the chemist would probably have failed to find any such constituent. It is worthy of consideration however, whether such silica as composed the older spicules may not, at least when under the influence of the growth force of the younger sponges, be to some extent soluble.

Further observations regarding the late maturity and the winter growth of some sponges will be found recorded in the general remarks concerning *Spongilla aspinosa*, *S. lacustris* etc.

As to processes of gathering—I have already mentioned the advantages obtained by the use of the "scraper net" in relatively deep water and in connection with perpendicular timbers etc. At depths of two feet or less, great facility of action is gained by wearing high rubber boots and wading after our specimens, to pick from the bottom stones, sticks or pieces of waterlogged timber, under which they may be concealed. Where the water is deeper, of course a boat must be used, to approach the floating, submerged or dependent sponge-bearing substances. A large, strong knife or a paper-hanger's scraper will be found convenient for hand work at short range. A case containing trays an inch or so in depth is suitable for carrying the smaller specimens; the larger will of course require vessels of greater size. On reaching home or headquarters it is well to select some specimens of characteristic shapes and containing gemmules, for storage in dilute alcohol, making use of wide mouthed bottles to avoid crushing them. The rest may be spread upon boards in sheltered situations, in the shade (for the sun bleaches them rapidly) and left to dry; turning them every few hours to prevent decomposition. If time is limited or the specimens are large, artificial heat may be necessary; but, whatever process is used, the drying must be *thorough*, or mould will soon cover the sponges with a mycelium which may be beautiful enough in itself, but is far from agreeable or sightly as a feature of the sponge. Whether they are to be dried or preserved in alcohol, they should be dealt with promptly and on

no account left to lie long in the water after being gathered. Preserve from dust in covered boxes.

For the determination of species, a few general directions may suffice, and even these will be soon modified to suit the tastes or the ingenuity of the worker.—It is assumed that the investigator has already noted the general appearance of the sponge in hand; its color, size, compactness; whether simply encrusting, or cushion like; sending out finger-like processes etc. These indications may help an experienced collector to a guess; but there are very few species that even such a one could name, with any confidence, before he had made and examined microscopic preparations of the same.

A stand, supporting a dozen or more test tubes, say three fourths of an inch in diameter by an inch and a quarter in depth; a dropping bottle containing nitric acid, and the usual materials and apparatus for mounting in balsam, are all the appliances needed. As the processes to be described are certain to disturb the normal relations of the several classes of spicules to each other, it is well before the dried specimen has been much handled, to separate some clean portions of the outer or dermal film, lay them upon a slide and mount in balsam without further preparation. An examination of this may determine the presence and decide the character of the dermal spicules, if there are any pertaining to the species in hand. This precaution is necessary in view of the displacement of parts just mentioned, and also on account of the indiscriminating habit of the sponge-currents during life, which almost necessarily charge the tissues with various foreign particles, including vagrant spicules of its own and neighboring species. In practice, the rightful presence of dermal spicules in any species is often so doubtful, that it can only be settled by an examination of young sponges, grown under observation, from isolated statoblasts, whose identity has been satisfactorily determined.

Next, separate from the sponge some minute fragments, containing skeleton spicules, the dermal and interstitial tissues and a dozen or more gemmules. Place several of the last named with a few adherent skeleton spicules upon the centre of a fresh slide,—bring to the boiling point in one of the test tubes, five or six drops of nitric acid and by the aid of a dropping tube apply a single drop of the hot acid to the gemmules upon the slide. While the acid is partially destroying their cellular or granular crust, pour the remaining

fragments into the acid left in the test tube and boil violently, until all the tissues are destroyed and the spicules left as a sediment upon the bottom of the tube. Fill up the tube with water and stand it aside to settle; which may take an hour or more. The few minutes that have elapsed will probably have been as much as the gemmules upon the slide will bear: they must not be left so long as to destroy the chitinous coat, nor is it well, though a common practice, to *boil them upon the slide* for this often smears and disfigures it with frothy matter. Remove most of the acid by trickling drop after drop of water over the slide while held in a slightly inclined position. Wipe off all the water that can be reached and apply repeated drops of strong alcohol to take up the remainder. When this is so far accomplished that the gemmules will absorb benzole freely and receive their covering of benzole or chloroform balsam without *clouding*, apply the balsam and a cover glass. This process of removing moisture by the use of alcohol, rather than by drying over a lamp, is preferred, although it requires more care and time, because the gemmules are less likely to be distorted in shape and the cells of the crust to become filled with air, if they are kept always under fluid. Yet if the mounted gemmules, when examined, appear black, showing an accidental intrusion of air, much of this can be removed by carefully heating the slide over a lamp.

If this mount has been successful, the gemmules are now so transparent that their surrounding spicules can be readily seen and the genus determined, by the aid of the "Key" hereafter given; but a better view of the detached spicules is necessary, and may be obtained by mounting some of the contents of the test-tube. If the lately suspended spicules have now settled, carefully pour off all the water except one or two drops; though if there has been much acid used it may be better to wash them a second time. Shake up and place a sufficient quantity upon one or more slides, being careful not to leave the contained spicules in too dense a mass. I have found it best to allow the water to evaporate from these slowly; as, if hurried over a lamp, each spicule is often margined with minute globules that it is impossible afterward to remove. However, when the slide is apparently quite dry, it may be safely exposed a moment to the heat, to make sure of it, and then covered with balsam and glass as usual.

The investigator has now before him all the elements necessary for solving his *specific* problem, according to the formulæ which

follow:—the normal sponge, the dermal film, the transparent gemmule, and a display of the detached spicules. Neither would alone answer, but the series will settle all points, excepting in the case of the genus *Carterius*. When this is suspected, the gemmules should first be examined *dry*; and, in preparations for mounting, great care should be taken to avoid the destruction of the tendrils, (cirri) (Pl. VI, figs. iii, iv, v. and vi), by the prolonged use of strong acid. Expert microscopists will improve their gemmule mounts by dividing some of them with a thin knife, endeavoring to make the section through the foraminal aperture; this, in the case of species having long birotulates, such as *Meyenia crateriformis*, (Pl. V, fig. vi,), is of the utmost importance.

"Seniors" in microscopy will please pardon the minutiæ of the processes just given, as they were necessary to make them available for the "freshmen." All are reminded that the above directions as to collection and examination refer to mature sponges only. It is seldom safe, or even possible, to *name* one, in which no gemmules can be found. If a course of study is undertaken, involving the histology and physiology of fresh-water sponges, many peculiarities will of course be observed that have not been alluded to here. One of them concerns the development of the spicules and, if not understood, will pretty certainly mislead the beginner into the supposition that he is examing a novel species. Both the skeleton and dermal spicules of *young sponges* are frequently marked with bulbous enlargements at the middle and often half way between the middle and each end of the spicule. These seem to indicate an immature condition, as they disappear when the spicules are fully formed.

A few words may be needed to justify the specific groupings I have adopted. I am well aware that objections may be made to so large a use of what some will call a "trinomial nomenclature." Without expressing an opinion as to the policy of the practice as regards other branches of the animal kingdom, in the case of the sponges I think it clearly unavoidable; for the reason, that the inert parts that have just been described as typical, share with the vital amœboid cells, their well known characteristic of unlimited variability. Were all the names that have been dropped or marked as varieties to be recognized as full species, on the ground that the specimens so designated do not exactly resemble any others, the literature would be encumbered with a mass of names represent-

ing forms that no description could distinguish, and no one of which would probably entirely correspond with the next specimen collected by its author from the same stream. This variability in forms that were considered typical when the first of a species was collected and named, is a fact in science that will not fail to impress any who may gather from many waters and through a wide extent of country.

Among some very incomplete memoranda of my collections and receipts, I find it recorded that I have examined *Spongilla fragilis* from at least 32 localities in 18 North American States; *S. lacustris*, from 26 localities in 16 states; *Meyenia fluviatilis* from 25 localities in 14 states; *Tubella pennsylvanica* from 18 localities in 11 states etc. Had a perfect list been kept, the figures might be largely increased. And this is the lesson most obviously taught:—hardly any two specimens are exactly alike in their so-called typical features; but all may be *grouped*, as in the case of those brought together under any of the above designations, and common definitions or descriptions will, without undue elasticity, cover them all. The varieties I have retained are such as were originally considered good species, and have generally some slight peculiarity to recommend them; but to the student I would say, "Get your genus right and your species right, and then it will matter little whether you associate it with any variety."

The following "Diagnosis" was prepared at my request by Prof. Franz Vejdovsky, of the University in Prague, Bohemia, to give information as to the number of reliable species of fresh-water sponges known by students at the present time to inhabit European waters, with their proper synonomy etc., and is far more reliable than I could hope to make it from the scattered literature of the subject. Professor Vejdovsky has greatly aided my work by thus furnishing, in manuscript, a German translation from his Bohemian text; for the English version of which I am further indebted to my friend Prof. Benjamin Sharp of the Academy of Natural Sciences of Philadelphia. As the classification adopted differs from that of Mr. Carter, which, for many reasons, I prefer to follow, it has seemed to me best to present the paper *as a whole* in this place, instead of collating the species and distributing them amongst my descriptions. Due reference will, however, be made to all in their proper order according to Carter's system.

DIAGNOSIS OF THE EUROPEAN SPONGILLIDÆ.

Translated from the Bohemian of Prof. Fr. Vejdovsky, in Prague.

Fam. SPONGILLIDÆ

(A)—*Sub-Fam. SPONGILLINÆ, Carter.*

"Gemmulæ, sometimes single and sometimes collected into groups; generally surrounded by an air-chamber-layer, in which the gemmulæ spicules are embedded.

(I) **Gen. SPONGILLA**, Auct.

With long, smooth skeleton spicules and short, either straight or curved, smooth or rough parenchyma spicules. Gemmulæ either entirely smooth or with an external air-chamber-layer, in which the gemmulæ spicules are either tangential or radial, or entirely irregularly embedded.

(a) **Sub-gen. EUSPONGILLA**, Vejdovsky.

Gemmulæ always single. (Besides the European species, most of the exotic species to which Carter gives the generic name of *Spongilla* belong here.)

(I) **Euspongilla lacustris**, Auct.

Syn.—	*Spongilla*	*lacustris*, (?) Linn.
1788	"	*canalium*, (?) Gmelin.
1816	"	*ramosa*, (?) Lamarck.
1842	"	*lacustris*, (?) Johnston.
1853	"	" Lieberkühn.
1866	"	" Bowerbank.
1870	"	*lieberkühnii*, Noll.
1877	"	*lacustris*, Vejdovsky.
1877	"	*jordanensis*, "
1881	"	*lacustris*, Carter.
1882	"	" Dybowski.
1883	"	(*Euspongilla*) *lacustris*, Vejdovsky.
1883	"	" " *jordanensis*, "
1883	"	*lacustris*, Retzer.
	Var. *spon. lacustris ramosa*, Retzer.	
	" " *lieberkühnii* "	
1884	*Euspongilla*	*lacustris*, Wierzejski.

Diagnosis:—Colony (Stoecke) branched or cushion-like, grass-green, yellowish or brownish. Osculæ and pores indistinct but everywhere numerous. Skeleton spicules, straight or slightly curved, sharp pointed, smooth and enclosed in bundles in a horny sheath. The parenchyma spicules are present in variable numbers, generally moderately curved and set thick with fine spines: at times, however,

when few in number they are smooth. Gemmulæ almost entirely naked, without the external air-chamber-layers, and with very few spicules. In other cases they are covered to a greater or less depth with a layer of minute cells filled with air. At times this layer is surrounded with a distinct horny membrane, although it is often wanting. In the air-chamber-layer are imbedded either radially, tangentially or very irregularly, the gemmulæ spicules, which resemble the parenchyma spicules in external form and variability as to numbers. Ordinarily they are curved and thickly spined ; rarely entirely smooth.

Remarks.—*Euspongilla lacustris* is found in nearly all Europe, as an inhabitant of both running and still water. As the above Diagnosis shows, these fresh water sponges are liable to great variations, especially in external form, and in the quantity, as well as the form, of the parenchyma and gemmulæ-spicules. Based on these variations, *Euspongilla lacustris* would be divided into many species and varieties. Without doubt we have here a very variable fundamental (grund) type, out of which new species are beginning to form. Future careful researches, principally by experiment, will show where lies the cause of the above mentioned variability in the form and quantity of the parenchyma and gemmulæ spicules.

Let us first examine those forms that have been looked upon as indicating distinct species.

We may take as typical, that form in which there are but few parenchyma spicules in the tissues, and in which the gemmulæ are perfectly smooth and but sparingly supplied with covering spicules (Belegnadeln). This form of *Euspongilla lacustris* has been regarded by Lieberkühn, and partly by Bowerbank, as the real *Spongilla lacustris*; and I have also considered it such, in my paper "Die Süsswasser Schwämme Böhmens" and so it is also represented by Retzer. In my "Monograph" I have, however, at the same time, pointed out that in one and the same colony (Stoecke), other forms are found with rough parenchyma spicules and with covering spicules (Belegnadeln) and seem to indicate a transitional stage towards those that have been looked upon as distinct species.

The nearest of these is *Spongilla leiberkühnii* described by Noll (Zoologischer Garten) in 1870, and also by Retzer, who, under the same name, described it as follows:—"Forms encrustations on wood and stones, from which rise, frequently free, cylindrical processes as long as one's finger. Skeleton spicules smooth, gradually pointed,

bound into fascicles, which are either long threads, or are placed as a network in the tissues. Hooked spicules cover the gemmulæ and are widely dispersed through the tissues. They live in ponds and quiet flowing water and appear to be the most widely distributed species of Germany."

Although from this description of Retzer's it is evident that *Spongilla lieberkühnii* only slightly differs from his *S. lacustris*, I thought it necessary to examine for myself the nature of the form in question. From a small fragment of *S. lieberkühnii* for which I must thank Prof. Eimer, I clearly recognize its identity with *S. lacustris*. In the form of the gemmulæ and the scarcity of the covering spicules I find no difference between them; sections of the gemmulæ prove that the air-chamber-layer is more or less developed and its surface may be with or without a horny membrane; which is also the case with *Euspongilla lacustris* in various localities in Bohemia.

The immense, even predominating quantity of the strong, rough parenchyma spicules, and an equally large number and variety of the external form of the gemmulæ spicules—these are, on the other hand, the striking characteristics which strongly suggested the recognition of a similar form from the Jordan Pond, near Tabor, in Bohemia, as a distinct species, (*Euspongilla jordanensis*). But the quantity of sponge material that has been at my disposal for some years, convinced me otherwise. In some specimens from the Elb, near Königgrätz and from a pond near Poiakek (?) I found the gemmulæ and covering spicules to correspond with each other, and with the characteristic type of *S. lacustris*; while in single branches, they were identical with the same features in *E. jordanensis*, from the Jordan Pond; and at the same time a corresponding quantity of rough parenchyma spicules was found in its tissues. We must therefore unite *E. jordanensis* with *E. lacustris*.

E. lacustris, var. *macrotheca*, very nearly resembles the following species.—

(2) **Euspongilla rhenana**, Retzer.

Syn.— 1883 *Spongilla rhenana*, Retzer.

This interesting species was first described by Retzer in the following terms:—"It differs from the other species by the *smooth* gemmulæ spicules."

"It encrusts pieces of wood, bushes and the like, sending out a few small processes; and also in many places forms thick masses. The skeleton spicules are straight or slightly curved, abruptly or

more gradually pointed. Their thread-like fascicles form a compact network. The gemmulæ spicules are *smooth*, symmetrically bent near each end, and form a thick layer around the gemmules; but are sparingly distributed through the tissues. The gemmulæ have a tolerably thick outer wall and are found everywhere in the sponge."

"*Habitat*:—Altrheim (?) near Eggenstein, (in the vicinity of "Karlsruhe). According to Prof. Nüsslin, whom I thank for the specimens, the sponge when living is green, and at all times can be found on fascine bushes (*Faschinen gestraeuch.*")

Through the kindness of Prof. Eimer in Tübingen, I was enabled to examine a fragment of *Euspongilla rhenana*, and can offer some additions to the description of Retzer.

The gemmulæ have the form and size of those of *E. lacustris*, but the polar aperture (*mikrodiode*) is surrounded by a broad, plate-like funnel. Upon the chitinous membrane is a very thin air-chamber-layer consisting of 2–3 cells overlying one another. This layer was rarely deeper than 5–6 cells in a column. The latter support the greater number of spicules. They generally lie tangentially upon the surface of the gemmule and very few are embedded radially in the air-chamber-layer. In shape these spicules are very variable, and generally three principal forms can be determined. The most plentiful are those which resemble the common skeleton spicules; a very few, those mentioned by Retzer, are bent double and such are also scattered singly through the parenchyma; finally, there are found upon the surface of the gemmulæ, spicules that are slightly bent and compressed in the centre.

The auxiliary apertures (neben-mikrodioden), numbering 3–6, upon the surface of the gemmulæ, are worthy of notice. About every tenth gemmule has, near the principal aperture, some lateral funnels; which fact makes this form resemble the species described by Carter from British Columbia, under the name of *Spongilla multiporis*.

(b) Sub-gen. SPONGILLA, Wierzejski.

From 2–30 gemmulæ as a rule, grouped in a common covering, or placed pavement-like along side of one another. Mostly there is a deep air-chamber-layer, through which smooth and rough spicules are scattered.

(3) **Spongilla fragilis**, Leidy.

Syn.—

1851	*Spongilla fragilis*, Leidy.	
1863	"	*lordii*, Bowerbank.
1870	"	*contecta*, Noll.
1878-84	"	*siberica*, Dybowski.
1883	"	*contecta*, Retzer.
1884	"	*fragilis*, Vejdovsky.
1885	"	*lordii*, Wierzejski.
1885	"	*fragilis*, "
1885	"	" Petr.
1886	"	*glomerata*, Noll.

Colony not branched; pale or brown in color, with large osculæ which, as a rule, are grouped in large cavities of the surface. Pores numerous and small. Skeleton spicules, nearly straight or but slightly bent; sharp-pointed, smooth, not rarely thickened in the middle. Gemmulæ spicules numerous, straight or curved, with many minute spines. Gemmulæ small, spherical, with a high, generally horn-shaped, polar tube, which is filled with air and projects from the air-chamber-layer; the latter consists of large, radial rows of cells. The groups of gemmulæ, according to the species (?) and the place of development, present two principal forms;—the basal groups are shallow; and here the gemmulæ are placed pavement-like, close together; those formed in the parenchyma consist of 2 or 3—30 and even more gemmulæ, forming spherical or hemispherical masses.

This species, *S. fragilis*, first described by Leidy, in America, was later described in Siberia by Dr. Ben. Dybowski, and finally by Noll, as *S. contecta* (and *S. glomerata*). Recently it has been observed in Russia, (in Donec (Donetz?) near Charkow), in Galicia, Bohemia and England and has been described repeatedly by Dybowski, Retzer, Carter, Vejdovsky, Wierzejeski and Petr.

(B) Sub-Family, MEYENINÆ, Carter.

Gemmulæ generally single, surrounded by an air-chamber-layer in which amphidiscs are embedded in one or more series, one above another. They are either star-shaped or have entire margins.

(II) Gen. TROCHOSPONGILLA, Vejdovsky.

With smooth, (*T. leidyi*), or rough, (*T. erenaceus*), skeleton spicules; amphidiscs smooth with entire margins, embedded at the base of an air-chamber-layer. Only one species has been found in Europe.

(4) **Trochospongilla erenaceus,** Ehrenberg.

Syn:—
1846 *Spongilla erenaceus,* Ehrenberg.
1856 " " Lieberkühn.
1877 " " Vejdovsky.
1881 *Meyenia* " Carter. .
1883 *Trochospongilla erenaceus,* Vejdovsky.
1883 *Spongilla* " Retzer.
1885 *Trochospongilla* " Wierzejski.

Trochospongilla is of considerable dimensions, covering foreign bodies in cushion-like incrustations; of a whitish or straw yellowish color; skeleton spicules sharply pointed at both ends; surface, except at the extremities, covered with powerful spines. Parenchyma spicules, correspondingly (?) small, smooth, and very often swollen in the middle. Gemmulæ covered with spool-like amphidiscs whose rotules have entire margins. They lie at the base of a deep air-chamber-layer which consists of radially placed hollow columns, that are divided into a number of chambers by cross-partitions.

Trochospongilla erenaceus has been observed in many places in Europe. In Germany by Ehrenburg; in Bohemia by Vejdovsky; in Galicia by Wierzejski, and in Russia by W. Dybowski.

(III) **Gen. EPHYDATIA** Gray. Lamarck.

Skeleton spicules either entirely smooth or entirely rough; though sometimes both forms are present together. In the air-chamber-layers, around the gemmulæ, are embedded amphidiscs with star shaped rotules, in one, two or three layers placed one over the other. In the first instance they may be of equal length, but frequently their lengths are unequal.

(5) **Ephydatia mülleri,** Leiberkühn.

Syn:—
1816 *Spongilla pulvinata,* Lamarck.
1856 " *mülleri,* Lieberkühn.
1877 " " Vejdovsky.
1878 *Trachyspongilla mülleri,* Dybowski.
1882 *Meyenia* No. 2.
1882 *Ephydatia* No. 2.
1883 " *mülleri,* Vejdovsky.
From A. Form B. var. *astrodiscus,* Vejdovsky.
1883 *Ephydatia amphizona,* part.
1883 *Spongilla mirabilis,* Retzer.
1885 *Meyenia mülleri,* Wierzejski.
1886 *Ephydatia* " Petr.

Colony cushion-like, rarely branched, bright green, yellow, yellowish-brown or white, with large osculæ, which lead to a system of small canals. The skeleton spicules are either entirely smooth or entirely rough or both forms are found together in the same colony. Their degree of roughness is very different, as the spines are sometimes quite indistinct, at others very conspicuous. The spicules are either straight or slightly curved; sharp pointed and fasciculated within a horny sheath. The gemmules are surrounded with shallow apertures, slightly flattened from above downward through air-chamber-layers of greater or less depth. Amphidiscs numerous; ordinarily in a single layer, but sometimes in two layers (*E. amphizona*) and occasionally in three layers (*S. mirabilis*), set one over the others. In the last case the external layer forms an imperfect or broken series of amphidiscs. The axes of the amphidiscs are short, relatively to their thickness; the rays either smooth or notched on their edges.

Ephydatia mülleri is known in Europe, in Germany, Bohemia, Russia, Galicia, and England.

(6) **Ephydatia fluviatilis**, auct.

Syn:—

1788	*Spongilla*	*fluviatilis*,	(?) Linn.
1788	“	*canalium*	(?) “
1816	“	*pulvinata*	(?) Lamarck.
1842	“	*fluviatilis*	(?) Johnston.
1856	“	“	Lieberkühn.
1863	“	“	Bowerbank.
1867	*Ephydatia*	“	Gray.
1877	*Spongilla*	“	Vejdovsky.
1881	*Meyenia*	“	Carter.
1882	*Ephydatia*	“	Dybowski.
1883	“	“	Vejdovsky.
1883	*Spongilla*	“	Retzer.
1884	*Ephydatia*	“	Wierzejski.
1886	“	“	Petr.

Amorphous, cushion-like colonies of an emerald, or bright Isabella-yellow color. Skeleton spicules smooth throughout, slightly curved and sharp-pointed. Parenchyma spicules (?) also smooth, small and very slightly bent. Gemmulæ small, yellow with a thick horn-membrane; the external air-chamber-layer surrounded by a thin chitinous covering. In this layer toothed amphidiscs are embedded, having either smooth or spinous shafts that are constricted in the middle and twice as long as the diameters of the rotulæ.

In Europe *E. fluviatilis* is found in France, England, Germany, Bohemia, Galicia and Russia.

(7) **Ephydatia bohemica, F. Petr.**

Syn.— 1886 *Ephydatia bohemica* F. Petr.

Colony very small, green, and is found living (parasitic or symbiotic) in the colonies of *Euspongilla lacustris.* Skeleton spicules straight or slightly curved; at times covered with fine spines. Parenchyma spicules numerous, straight or somewhat bent, covered with spinous processes as in *Carterius stepanowii.* Gemmulæ with large apertures (mikrodioden) whose pole is expanded into a broad, irregular funnel. In the air-chamber-layer are embedded amphidiscs of equal lengths; some of which, however, project above the surface of the gemmulæ. Their shafts are slender and longer than the diameter of the nearly regular, star-shaped, terminal discs. The rays of those discs are finely notched. Rarely does the mikrodiode funnel run into a lengthened tube.

Ephydatia bohemica is, as yet, found only in one place in Europe, viz: in Kvasetic near Deutschbrod in Bohemia.

This species is very characteristic, as it has a certain relationship to, if it is not a transitional form of the following genus *Carterius*; in the fact that the amphidiscs are indistinctly of two lengths; and the tendency shown though rare, for the mikrodiode to lengthen into a polar tube, which is so characteristic in *Carterius.*

(IV) **Gen. CARTERIUS**, Potts.

Syn.— *Dosilia*, Dybowski, Gray.

Skeleton spicules smooth; those of the parenchyma spinous. Gemmulæ with a deep, straight air tube which terminates in an irregular, lobulated disc.

In the air-chamber-layer are embedded amphidiscs of two lengths; one set being as long as the thickness of the air-chamber-layers; the others, just as numerous (?), as the former, project beyond the surface of the gemmulæ.

(8) **Carterius stepanowii,** Petr, (Dybowski.)

Syn.—
1863 *Spongilla baileyi,* (?)Bowerbank.
1881 *Meyenia* " (?) Carter.
1884 *Dosilia stepanowii,* Dybowski.
1881 *Carterius* " Petr.

Colony slender, branching, fine to fibrillar, (?) surrounding the stems of water plants. It is of a bluish-green color; dimensions insignificant. Skeleton spicules smooth, straight or curved, sharp-pointed. Parenchyma spicules numerous, bent or straight and

thickly set with spines, which are largest at the middle of the spicules. Gemmulæ marked by a polar air tube which is straight or slightly bent, and terminated by a wavy, lobulated disc. The air-chamber-layer is formed of numerous small cells. Amphidiscs of two lengths, of which one third or even a half may project beyond the surface of the air-chamber-layer. The amphidiscs are thickly set with spines.

Carterius stepanowii was first discovered in a lake near Charkow in Russia, and was in 1885 found in Bohemia by F. Petr, in a pond near Deutschbrod."

The above paper of Prof. Vejdovsky has been copied in full, as a very valuable statement of the present status of the specific study of fresh water sponges in Europe, more particularly upon the continent.

SYNOPSIS.

Of the plan of Classification proposed by H. J. Carter, F. R. S. etc., (Ann. and Mag., Feb. 1881) already referred to, he says:—"I found it necessary to make the fresh water sponges the fifth family of my sixth order of the *Spongida* generally, under the name of "*Potamospongida,*" with a single group, at present named "*Spongillina.*" Hence so far they will stand thus:—

Class SPONGIDA.

Order VI, HOLORHAPHIDOTA.

Char. Possessing a skeleton whose fibre is entirely composed of proper spicules, bound together by a minimum of sarcode. Form of spicule variable.

Family 5, POTAMOSPONGIDA.

Freshwater Sponges.

Group 19, *SPONGILLINA.*

Char. Bearing seed like reproductive organs called statoblasts."

To the five genera named by him, two have been added, to define some recently discovered American types, so that the list now stands.

Genera:— 1. *Spongilla ;* 2. *Meyenia* ; 3. *Heteromeyenia* ; 4. *Tubella;* 5. *Parmula*; 6. *Carterius ;* 7, *Provisional,* (the possible material for a new group including *Uruguaya, Lubomirskia, Potamolepis etc.*)

As has been intimated, these genera have been founded upon the peculiarities of the gemmule-spicules, except in one instance, which

is determined by other appendages of the gemmulæ. Assuming that the illustrations will sufficiently show the meaning of the special terms used, the student is referred, without further preface to the following "Key," by comparison with which he will without hesitation be able to decide the *generic* status of his specimen.

Fuller definitions will be given as each genus comes under notice.

KEY TO THE GENERA OF FRESH-WATER SPONGES. Carter's System.

1. Gemmulæ surrounded by acerate (Pl. VII c.c.c) or cylindrical (Pl. VII b.b.b) spicules alone. (Plate V, figs. i, ii, iii.) SPONGILLA.
2. " surrounded by birotulate (Pl, IX. fig. iii. b.b.b etc.) spicules of a *single* class or type,[1] resting by one (the proximal) rotule upon the chitinous coat; diameters of the rotules equal or nearly so. (Pl. V, fig. iv, v and vi.) MEYENIA.
3. " surrounded by birotulate spicules of *two* classes or types, both resting by one rotule upon the chitinous coat; the less numerous class longer than the other. (Pl. VI, fig. i,) (Pl. XI. b.c. etc.) HETEROMEYENIA.
4. " surrounded by inæquibirotulate spicules(Pl. XII fig. i, ii, and iii. b.c.d. etc.) of which the proximal rotule is much larger than the distal one. (Pl. VI. fig. ii.) TUBELLA.
5. " whose "crust" is charged with spicules from which the distal rotule has been entirely eliminated, leaving the proximal rotule surmounted only by a short, pointed portion of the shaft. (See Ann. and Mag. 1881, Pl. 5, figs. 1 and 2.) PARMULA.
6. " whose foraminal tubules are prolonged, their terminations broadly funnel-shaped or divided into cirrous appendages of varying numbers and lengths. (Pl. VI, figs. iii, iv, v and vi.) CARTERIUS.

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[1] Specimens are occasionally found with birotulates of a *single* type arranged in two or three concentric series. For this form Mr. H. Mills proposed (Proc. Am. Soc. of Microscopists, 1884) the new genus *Pleiomeyenia;* while Prof. Vejdovsky has *merged* two species named on account of the same peculiarity into the common species *E. mülleri.* See "Diagnosis."

7. Sponges in which no gemmulæ have yet been discovered and whose classification may therefore be considered doubtful. *Uruguaya*, Carter, (Ann. and Mag. etc. 1881. p. 100 and Pl. VI. fig. 17.); *Lubomirskia*, Pallas. *Potamolepis*, Marshall, (Zeit. für Naturwissenschaften XVI. N. F. IX Bd and Taf. XXIV.)

(Particular attention is invited to the illustrations, from plates prepared by the Photo-Engraving Co. (N. Y.). Plates Nos. V and VI are from original drawings by Dr. C. W. de Lannoy, and represent either the whole or portions of gemmules, with their associated spicules, to explain the typical characteristics of the different genera. They are variously magnified as suited his several subjects. Plates VII–XII incl. are also from original drawings, magnificently executed by Miss. S. G. Foulke. They include altogether thirty-six separate groups, representing every class of spicules, in an equal number of species or varieties, all equally magnified and drawn to scale. They may therefore be relied upon as depicting the spicules as the student himself will see them: neither diagrammatic nor idealized. The power used was 400 diameters, which has been reduced upon the plates to one half, say 200 diameters.)

(The measurements accompanying the descriptions of nearly all the North American species are averages resulting from micrometric measurement of from 15 to 30 individual spicules, and may be conviently reduced to millimeters by moving the decimal point two places to the right and dividing by four. The variability in different specimens is so great that I cannot regard any measurements as of exact specific value.)

(I) Gen. SPONGILLA, Carter.

Part of old genus *Spongilla*, Auct. * (Plate V, figs. i, ii and iii.)

Gen. Char. Skeleton spicules acerate, generally smooth, curved, fusiform, pointed; mostly accompanied by flesh spicules. Gemmulæ globular; crust variable in thickness or absent altogether; accompanied by or charged with minute acerates, (Pl. V, b.b.b. also Pl. VII b.b.) smooth or spined, imbedded in or lying upon it or on the chitinous coat. Modified from Carter.

When the old genus *Spongilla* of authors was sub-divided by Mr. Carter in 1881, this term was very appropriately restricted to that type which includes the species most widely diffused and most frequently noticed throughout the world.

The following brief summaries of specific points may serve as a guide to the intending student, enabling him at a glance to select the species which his specimen most nearly resembles, without having to read many pages of inapposite matter. (It must be remarked in explanation of the omission of some names, that the verbal descriptions of some of the older species, as copied from their authors, fail to give diferential points that can be made use of in this connection. In the treatment of my own discoveries or those of others that have come to me for examination, I have desired to be thoroughly conservative, grouping those together that have an undoubted relation to one another and not creating either species or varieties unless they appear necessary to aid in study of the subject. I hesitate however to drop species, the type specimens of which I have never seen; although it is probable some of them might become synonyms to advantage.)

KEY TO THE SPECIES OF THE GENUS SPONGILLA.

(*a*) *Sponge branching.*

1. Slender, cylindrical, waving branches; dermal spicules minute *smooth* acerates; gemmules few, sponge evergreen. (Pl. VIII (fig. vi. *S. aspinosa.*
2. Branches generally tapering, rigid; less frequently cylindrical and flaccid; skeleton spicules smooth; dermals pointed, spined acerates; gemmules *after maturity* numerous; with or without granular crust; spicules cylindrical, curved, spined. (Pl. VII, figs. i-vi.) *S. lacustris.*
3. Branches small; crust of gemmules thin, spicules *smooth.* *S. rhenana*

(*b*) *Sub-branched.*

4. Spines of dermal spicules longest at the centre; gemmule spicule round-ended, covered with recurved spines. *S. alba.*
5. Short compressed branches; gemmule spicules at various angles. *S. cerebellata.*

(*c*) *Sponge without branches.*

6. Gemmulæ with thick crust of polyhedral cells arranged perpendicularly; spicules of gemmulæ *smooth.* *S. carteri.*
7. Crust as in the last species; a layer of minute spined acerates intervened between it and the chitinous body, besides that which is exterior to it. *S. nitens.*

8. Spicules of gemmulæ very short, trapezoidal. Gemmule adherent, elliptical; aperture terminal. *S. navicella.*
9. Capsule around the gemmule, and chitinous body both spiculiferous. *S. bombayensis.*
10. Shafts of gemmule spicules smooth; heads composed of numerous short blunt or subacute spines. *S. botryoides.*
11. Gemmule spicules spined, particularly near the head. *S. sceptrioides.*
12. Color cinereous. *S. cinerea.*
13. Gemmules in layers or groups; apertures *upward* or *outward;* surrounded by a cellular parenchyma, charged with subcylindrical, spined spicules. (Pl. V fig. ii.) (Pl. VIII figs. i to iv.) *S. fragilis.*
14. Gemmules in hemispherical groups; apertures *inward*; surrounded by a parenchyma of *unequal* cells, charged with coarsely spined spicules, nearly as long as the less strongly spiniferous skeleton spicules. (Pl. V, fig. iii.) (Pl. VIII, fig. v.) *S. igloviformis.*
15. Resembling the above, but with spines more broadly conical, etc. *S. mackayi.*
16. Parasitic on *S. nitens*, with minute, curved dermal *birotulate.* *S. böhmii.*
17. Gemmules very large, chitinous coat thin; crust absent or inconspicuous; gemmule spicules smooth, or irregularly furnished with very long spines, frequently located near the extremities. Numerous dermal *birotulates.* *S. novæ terræ.*

(a) *Sponge* [illegible] *branched.*

(1) **Spongilla aspinosa,** Potts. (Pl. VIII, fig. vi.) Proc. Acad. Nat. Sci. Phila. Nov. 1880, p. 357 etc.

Sponge green, encrusting, thin; upon a relatively thick basal membrane; thence sending out numerous radiating, long, slender, cylindrical branches, occasionally subdividing: texture very loose; surface rather smooth, pores conspicuous.

Gemmules very few in scattered bunches of ten to twenty or more, small, spherical, with a granular crust, surrounded by an irregular mass of spicules, resembling those of the skeleton.

"*Spongilla arachnoidea,*" named by H. James-Clark (Am. Journ. Sci. 1871 p. 426), and "*Siphydora echinoides*" by the same author ("Mind in Nature" p. 41, 1865) are not accompanied by such descriptions as will enable me to classify them intelligently.

Skeleton spicules smooth, straight or slightly curved, rather abruptly pointed; an occasional one acuate or malformed.

Outer dermal film charged with minute, straight or curved, smooth, slender, gradually pointed acerates.

Approximate measurements.—Diameter of gemmules 0·02 inches. Skeleton spicules 0·0113 by 0·00033 inches. Length of dermal spicules 0·00144 inches.

Habitat. Upon logs and timbers several feet below the surface of clear standing water, or upon sphagnum, grass, weeds etc. near the surface.

Locality. Collected at Doughty's Pond, Absecum, New Jersey; Brown's Mills, N. J.; Deep Creek near Portsmouth, Virginia etc.

Remarks.—This sponge was first collected by Mr. E. P. Cheyney, a very acute observer, during the summer of 1879 or 1880 in one of the Cedar swamps, near the New Jersey coast. In October 1881, the writer himself collected it, and since that date it has been the subject of frequent and careful observations. Doubt was at first felt as to whether the apparent branches were really self-supporting; but this was long since set at rest and the species is now seen to stand securely *near S. lacustris*, but not *of* it. Some interest may be felt in the following description of its favorite and characteristic locality.

The S. E. portion of the State of New Jersey is, for the most part, a broad sandy plain, not greatly elevated above tide level. It was formerly covered by a dense growth, chiefly of "scrub" pines, and was known as the "Pine Barrens." The few depressions through this district form water courses, along which the drainage of the surrounding neighborhood creeps sullenly, through jungles of cedar mingled with maple, magnolia, and other deciduous growths. Just before Absecum Creek, which has thus wandered for miles through densely wooded cedar and maple swamps, finally loses its identity in the "Thoroughfare," that winds for many a mile among the still flatter marsh lands that line the coast, a low mill-dam checks its course, and forces it to spread its clear, dark waters over acres of refreshing pools, dotted with reed-fringed islets. Here, in clumps, grow the curious leaves and umbrella-like flowers of the American Pitcher Plant; on the margin of the pond are many orchids, those most aristocratic of flowers; in the hollows the *Droseras* or Sundews are doing their best to entrap a few of our insect enemies. The trees, that, years before, had darkened the glen with

their shade, killed by the too abundant water, now stand gaunt and desolate above it, "bearded with moss" that hangs and flutters from their otherwise naked branches.

At many places in this beautiful pond the fallen timbers, water-logged at depths of three to six feet, are lined for yards with this sponge; sometimes only as a smooth, green, enveloping sheet, but at other places reaching out long, radiating branches for six inches or more, swayed delightfully by the clear current. Not only in the "perfect days" of June or through the heats of mid-summer, is the sponge thus verdant and thrifty; but when December has robbed the lake of most of its vegetable forms,—even after February has for weeks covered it with a thick sheet of ice, the sponge has been seen still green and apparently in as healthy growth as ever.

Concurrently with this evergreen habit, we notice the unusual scarcity of gemmules at all times of the year, and feel warranted in inferring that, gifted as it is with this ability to with-stand a low temperature in its growing state, it does not *need* to form "protected gemmules" to conserve its life during hybernation.

In the microscopical study of *S. aspinosa*, the distinctive feature is, undoubtedly, the presence upon the dermal film and amongst the generally smooth, slender, skeleton spicules, of great numbers of minute *smooth* acerates. These are not altogether uniform in size, however; and enough of an intermediate character are occasionally seen, to suggest the possibility that they may be merely initial and immature conditions of the skeleton spicules. The continued perennial growth of the sponge, makes this supposition the more probable; as there is no season in which, as in the case of most other sponges, it may be said to have reached maturity or completeness. In some preparations of it, aborted forms of skeleton spicules are found in considerable numbers and spherical or discoidal masses of silica, without spinous prolongations, or with but a single spine, are not infrequently met with.

(2) **Spongilla lacustris**, Linn. (Pl. V, fig. 1; Pl. VII.)

"Branched; branches long, round and sharp-pointed. Color dark brown, structure fibrous. Skeleton spicule curved, fusiform, gradually sharp pointed, smooth; sometimes more or less spiniferous. Flesh spicule thin, curved, fusiform, gradually sharp-pointed, spined throughout. Statoblast when fully developed globular; crust composed of granular cell-structure, charged with more or less curved, minute, stout, fusiform, sharp pointed acerates, covered with stout

recurved spines, arranged tangentially, or centrifugally, like the lines of a so-called "engine-turned" watch case." Carter, (Ann. etc. 1881.)

Syn. European:—See Vejdovsky "Diagnosis" under *Euspongilla lacustris*. p. 172, etc.

Syn. American:—

1863	*Spongilla*	*paupercula*,	Bowerbank.
1863	"	*dawsoni*	"
1875	"	*flexispina*,	Dawson.
1879	"	*lacustrioides*,	Potts.
1880	"	*abortiva*,	"
1880	"	*mutica*,	"
1880	"	*montana*,	"
1881	"	*multiforis*,	Carter.
1884	"	*lehighensis*,	Potts.

As this is the most widely known of all the fresh water sponges, and deserves a full and careful treatment, besides the analysis of it given by Prof. Vejdovsky, under his name *Euspongilla lacustris*, I have also copied Mr. Carter's description above, and now append the result of my own observations, founded upon collections in all parts of this country.

As found in infinite numbers of situations and variety of forms in North America, this sponge is green, when growing, as it does by preference, in the light: from a sessile base freely and repeatedly branching; branches cylindrical or more or less tapering; bristling with the points of radiating spicules; ends of the branches pointed or rounded. Texture loose; the branching processes made up of thick longitudinal lines of fasciculated spicules, united by single spicules or more slender fascicles, in a radiating manner. Pores numerous, large.

Gemmules sub-spherical, often scarce until late in the year, (November) when they are formed quite plentifully in the inter-spicular spaces, not only in the sessile portion, but throughout the branches of the sponge. Granular crust of the gemmules very variable in thickness; in some forms altogether wanting. Foraminal aperture infundibular.

Skeleton spicules curved, fusiform, gradually sharp pointed, almost uniformly smooth.

Dermal or flesh spicules variable in number, but generally very numerous; curved, fusiform, gradually tapering to sharp points; densely and entirely spined.

Gemmule spicules generally cylindrical, much and variably curved; somewhat sparsely spined; spines more numerous near the extremities, where they are long, acute, and frequently recurved. Upon the gemmules they vary from a horizontal to a nearly erect position, according to the thickness of the crust, and for the same reason are sometimes wanting and at others very numerous.

Hab. On stones and timbers everywhere; preferring running water.

Measurements. Diameter of gemmules 0.02 inches. Average length of skeleton spicules about 0.0108 inches.

Remarks.—*Spongilla lacustris* is certainly not introduced in this connection on account of any claims I desire to make as to authorship or discovery; but rather in the way of recantation or confession that in times past I have so frequently mistaken this name-child of the great Linnæus, clucking to it as one of my own little brood. Indeed it is to save others from a similar experience that I am particular to make this identification.

This species was one of the earliest known; though for years the distinction between it and *Spongilla* (now *Meyenia,*) *fluviatilis* was far from clear. It has been found in nearly all parts of the world where any sponges have been discovered. While many of the fresh water sponges appear to shun the light *S. lacustris* comes out boldly and flourishes in the full sunshine. For this reason and because of its resultant brilliant green color and its conspicuous branching habit, this sponge is better known than any other, and is more frequently gathered by the non-expert collector. I have received it from nearly all my correspondents in the United States and from almost every locality in which any have been collected.

In every place it prefers rapidly running water, where its growth is strong and vigorous. Perhaps my finest specimens were gathered at a place in Chester Creek, Pennsylvania, where the stream was narrowed to a width of ten or twelve feet, rushing between large masses of rock, many of which were coated with the sessile sponge and beautifully fringed with tapering finger-like processes, one half inch or more in diameter by several inches in length. In standing pools, on the contrary, it grows in slender cylindrical branches; as in the subsiding reservoirs on Fairmount Hill, Philadelphia, where it appears in slender, flaccid, yellow-green branches, with hardly

sufficient vitality to support themselves above the mud, slowly gathering around them.[1]

While *S. lacustris* is extremely variable, as to some particulars, upon this continent, (as Prof. Vejdovsky describes it to be also in Europe), in *essentials* the synonyms I have named resemble one another and the European type. These essentials, for comparison, I again describe as follows:—

1st. In general appearance, a green, branching sponge.

2nd. Skeleton made up of smooth, fasciculated spicules.

3rd. Dermal or flesh spicules, *fusiform acerates, entirely spined*, pointed.

4th. Gemmule spicules, whether few or many, generally *cylindrical*, more or less curved, rather sparsely spined, spines often recurved, acute.

5th. Gemmules either apparently wanting or abundant throughout the sponge; with or without granular crust.

As all the sponges above named will bear this description, I cannot see sufficient reason for separating them from the typical form, but many for grouping all together. Some, whose peculiarities are most conspicuous, will be briefly described as varieties.

S. lacustris, var. paupercula, Bowerbank. Proc. Zool. Soc. Lond. 1863 p. 470.

"Sponge coating and branching; surface smooth. Oscula and pores inconspicuous. Dermal menbrane aspiculous (?). Skeleton spicules fusiform-acerate, stout and rather short. Interstitial membranes aspiculous. Ovaries globular, smooth; spicula acerate, small, few in number." Bowerbank.

Loc. Water pipes of Boston, Mass.

S. paupercula, Bk. is, perhaps, that one of this group of synonyms about whose identity with *S. lacustris* there may be most hesitation. Its character is somewhat anomalous, as its locality and associations are peculiar. (See remarks as to *M. fluviatilis, v. acuminata.*) Growing originally in the ponds and reservoirs tributary to the Boston water-supply, it moved forward, and even so early as 1856 Prof. J. W. Bailey wrote to Dr. Bowerbank that "it grows abundantly in the water pipes (aqueducts?) by which the city of Boston is supplied with water from a small lake"; adding a suggestion as to the

[1]This is thus far the only instance in which I have found any sponge apparently growing upon a mud bottom; and even here it was doubtless planted upon something firmer, and the length of its branches was probably induced by the effort to lift itself up into greater purity and freedom.

possible diminution of the water way and contamination of the drinking water by its further growth.

I have not had an opportunity to examine the type specimen from which the above description by Dr. Bowerbank was prepared, but from the study of fragments received from Mr. Desmond Fitz-Gerald, Chief Engineer of the Boston Water Department, collected by him from Farm Pond and Cochituate Reservoir, near the head of the water system of that city (in all probability the same that Dr. Bowerbank describes), I am induced to class this as one of the many varieties of *S. lacustris*. In the dry state the sponge is very friable and its dermal surface soon crumbles off, which may in a measure account for the apparent absence of dermal and interstitial spicules from Dr. B's specimens. Mr. H. J. Carter records the finding of acerate, dermal spicules in those received by him from the same locality, and I have found them, though few in number, in the fragments sent to me. We may regard, therefore, the dermal and interstitial surfaces of *S. paupercula* as not *aspiculous* and assert that those found are not entirely smooth; as in nearly all a few spines may be discovered, particularly near the extremities.

The gemmule spicules are equally scarce and without pronounced character; their *relative* smoothness and greater proportionate length than in most other forms of this species are the noteworthy points. The gemmules are quite numerous, large and entirely devoid of "crust." Their shrunken contents, appearing through the transparent, crustless chitin, give them a peculiar waxen cast. It will be noted, as has before been incidentally mentioned, that in this, as in other cases, a paucity of gemmule spicules attends, as a necessary consequence, the absence of an enveloping crust.

S. lacustris, var. **dawsoni**, Bowerbank. Proc. Zool. Soc. London 1863 pg. 467.

"Sponge sessile, branching; surface smooth. Oscula and pores inconspicuous. Dermal and interstitial membranes abundantly spiculous; spicula fusiform-acerate, entirely spined; spines numerous, short and conical. Skeleton spicula acerate or sub-fusiform-acerate. Ovaria spherical; dermal spicula numerous, disposed in flat fasciculi or groups of spicules parallel to each other (?); groups irregularly dispersed; spicula acerate or sub-cylindrical, entirely spined; spines numerous, obtuse and ill defined. Sarcode aspiculous. Color in the dried state emerald green." Bowerbank.

S. flexispina, Dawson. Syn. Canadian Nat. and Geol. Sept. 1875.

S. lacustrioides, Potts, Syn.

This name was at first suggested under the belief that a distinct specific difference existed between the European and the American forms; an idea that has long since been given up. I now think the resemblance of these forms is quite as close as that of most of those grouped under this name in North America.

S. mutica, Potts, Syn.

This term was applied to an ordinary form of *S. lacustris* during the earlier part of my explorations, before I had learned that it was a very common habit of this species to be without both "crust" and gemmule spicules.

S. lacustris, var. **abortiva**, Potts.

The name *abortiva* was given to a form of *S. lacustris* first noticed at Fairmount Dam, Philadelphia, in which careful examination during the summer and autumn months of several years, had failed to discover any gemmules. About the 22nd of November 1883, however, upon again collecting the sponge in its original locality, I found, in one instance, the green sarcode leaving the lines of skeleton spicules and collecting in spots, where, a few days later, were found well defined but immature gemmules, entirely smooth and of a vivid green color;—a feature that lasted all winter. Some fragments in this condition were brought into the house and the warmth of the room was found not merely to retard the completion of the gemmules, but in many cases, to reverse the flow of the amœboid particles, which began to reform and rebuild the skeleton frame-work.

To quote from my note book of that date;—"The appearance of the sponge as now found, was as if the cells of green sarcode had congested or gathered together from their normal position upon the supporting spicules and had just formed immature statoblasts with a very delicate chitinous covering and as yet without either a granular crust or embedded spicules. The skeleton spicules in most cases were entirely bare and the statoblasts bright green." Of another specimen of the same sponge it is remarked.—"This resembled the last mentioned gathering, except that in some places the statoblasts were merely localized by a gradual flowing together of the green sarcode into spots; and the globular shape and chitinous coat of the gemmules had not yet been attained."

The whole of this observation has been of great interest to me first, as indicating the necessity of caution in accepting statements, asserting the entire absence of gemmules from sponges collected by

indifferent observers from remote districts, where their life history has never been followed;—next, from the light thrown upon the character of these bodies;—that they are probably neither ova nor ovaria,in any proper sense; but may be *gems* or gemmules, just as, in the vegetable world, we regard the buds of trees, bulbs, tubers etc;—places where the vital particles of the animal or the plant retire for protection during the winter season and for successful distribution in the spring: further, that this act is coincident with the disappearance, at least partially, of the sarcode from those parts of the sponge where the gemmules are found; and that it takes place in different situations and with varying species, at widely different seasons of the year.

S. lacustris, var. **montana**, Potts. (Pl. VII, fig. vi.) Proc. Acad. Nat. Sci. Phila. 1880 p. 357.

This variety was first sent to me by Prof. E. D. Cope, as collected in the well known Lake near the Mountain House on Catskill Mts., N. Y., at an elevation popularly stated to be 2500 feet above tide. Afterward, at my request, Dr. J. G. Hunt kindly sought for and found it at the same locality. As received from the latter collector the sponge was bright green with slender cylindrical branches.

Gemmules quite numerous throughout the sponge; often naked, but also frequently covered by a thick crust and an abundance of spicules, that are placed in a nearly erect position, embedded in the crust.

Skeleton spicules long, very slender, cylindrical, abruptly pointed.

Dermal spicules apparently very scarce, slender, minute acerates; entirely spined. (None are represented in the drawing.)

Gemmule spicules slender, cylindrical; more sparsely spined; spines erect, long, cylindrical; terminations rounded.

Meas. Diameter of gemmules 0.015 inches. Skeleton spicules, 0.0096 by 0.00015 inches. Length of dermal spicules 0.00375; of gemmule spicules 0.002 inches.

This sponge in all its parts is a very slender edition of *S. lacustris* but I think deserves a varietal designation.

S. lacustris, var. **multiforis**, Carter. Ann. etc. 1881, p. 88.

I understand Mr. Carter to agree with me in now regarding this as a variety of *S. lacustris;* the multiple openings being probably the result, in degree, of over maturity. There are no distinctive features except that the skeleton spicules in the fragments sent me are unusually large.

S. lacustris, var. **lehighensis**, Potts. (Pl. VII, fig. v.)

In this variety we find the skeleton and dermal spicules normal, while those of the gemmules are disproportionately large. The gemmule itself is relatively small, with an unusually thick granular crust, through which, embedded like *chevaux de frise*, the spicules project their points, crossing their lines in every direction. These are long, cylindrical, with long spines; those near the extremities often recurved; terminations acute.

Loc. Lehigh river Pennsylvania, near White Haven.

Meas. Diameter of gemmule 0.016 inches. Skeleton spicules 0.01035 by 0.00045 inches. Length of dermal spicule 0.002; of gemmule spicule 0.004 inches.

A somewhat similar form was collected at May's Landing, New Jersey; but in this the chitinous body was very thick; the granular crust less conspicuous; the spicules fewer, larger, and less regular in position and character. (Pl. VII, fig. iv.) It may be briefly described thus:—

Sponge green, encrusting; not conspicuously branched.

Gemmules small, crust thin, enveloped in a specialized capsule of interlacing skeleton spicules.

Skeleton spicules stout, sub-fusiform, smooth, gradually pointed.

Dermal spicules rather large.

Gemmule spicules variably robust, abundantly spined; spines long, acute, retrorse.

Meas. Length of skeleton spicules 0.0105; of dermal spicules 0.0021; of gemmule spicules 0.004 inches.

Loc. May's Landing, N. J.

(3) **Spongilla (Euspongilla) rhenana**, Retzer. See "Diagnosis." p. 174, etc.

(4) **Spongilla alba**, Carter. Ann. etc. 1881 p. 88.

"Massive, spreading, sub-branched. Structure fragile, tomentose. Color whitish. Skeleton spicule curved, fusiform, gradually sharp-pointed, smooth. Flesh spicule thin, curved, fusiform, covered with spines, longest in the centre where they are vertical and obtuse. Statoblast globular; aperture infundibular; crust thick, white; composed of granular cell-structure, charged with minute thick acerates, which are curved, cylindrical, round at the ends, covered with spines (especially about the extremities where they are longest and much recurved), arranged tangentially, intercrossing each other like the lines of an engine-turned watch-case." Carter.

Loc. Bombay.

Mr. Carter observes:—"The spicules of the statoblast here as well as in *S. lacustris* are considerably stouter, more curved, cylindrical and more coarsely spined than the flesh spicules of the sponge generally."

(5) **S. cerebellata**, Bk Proc. Zool. Soc. 1863 p. 465.

Carter thinks this is but a variety of the preceding species.

(*b.*) *Sponge not branched.*

(6) **Spongilla carteri**, Bowerbank. (*S. friabilis.*) Carter. Proc. Zool. Soc. etc., 1863, p. 469.

"Sponge massive, sessile. Color greenish or faint whitish yellow; structure fragile, crumbling. Skeleton spicule smooth, fusiform, curved, gradually sharp-pointed. Statoblast globular; aperture infundibular; crust composed of pyramidal columns of dodecahedral or polyhedral cells, hexagonal in the section, regularly arranged one above another in juxtaposition, perpendicularly to the outside of the chitinous coat, on which they rest; surrounded by a layer of minute fusiform, curved and gradually sharp-pointed, smooth acerates." Carter.

Loc. Bombay, Mauritius etc.

In the spring of 1885 specimens of this sponge were kindly sent to me by Col. Nicolas Pike of Brooklyn, New York, who had collected them many years before, while United States Consul at Mauritius. He writes:—"The specimens sent you were gathered by me at the Botanical Gardens, Pamplemousses, Mauritius. They were found growing in masses five or six inches in width, three inches thick and about four in depth. They fringed the southerly side of the pond about a foot below the surface of the water. They were very green when first taken and rather firm in texture. They covered a very limited area in this pond and were not found elsewhere on the island."

The courtesy of this gentleman has enabled me to observe a peculiarity in the gemmules of his collection that was not mentioned as to those from Bombay. While many of them appear to correspond with Mr. Carter's description above:—"aperture infundibular," I find many others having a tubular prolongation of the foraminal orifice, of a length fully one fourth the diameter of the gemmule. These tubules are surrounded like the rest of the chitinous body with columns of relatively large polyhedral cells; and as they partake of the brittleness of the sponge when dry, I fancy they must often be broken off and lost in carriage.

(7) **Spongilla nitens**, Carter. Ann. etc. 1881, p. 89.

"Form of sponge unknown. Structure reticulate; fibre rigid, composed of bundles of spicules united by a transparent colorless sarcode, which, in the dried state, gives it a hardness and vitreous appearance like that of *Spongilla corallioides* Bk. Skeleton spicule curved, cylindrical, smooth, sometimes very slightly inflated in the centre and at the extremities, which are round. Statoblast globular; aperture infundibular; crust composed of pyramidal columns of dodecahedral or polyhedral cells hexagonal in the section, regularly arranged one above another, in juxtaposition, perpendicularly to the outside of the chitinous coat, on which, by the intervention of a layer of the statoblast spicules, they rest; surrounded by a layer of minute, fusiform, curved acerates, thickly spined, especially over the ends, where the spines are longest and recurved, arranged tangentially; the same kind of layer immediately round the chitinous coat, where the spicules appear to be intermixed with the lower cells of the crust, leaving the latter free between the two." Carter.

Loc. Unknown; probably South America. River Ugalla, near Lake Tanganyika, Central Africa. (See *Spongilla böhmii.*)

(8) **Spongilla navicella**, Carter. Ann. etc. 1881, p. 87.

"Sponge unknown. Skeleton spicule curved, fusiform, smooth, gradually sharp-pointed. Statoblast adherent to the twig on which the sponge had grown; globoelliptical; *aperture terminal*, infundibular; no apparent crust; chitinous coat encased with a dense layer of minute, stout, short, thick, more or less curved, fusiform, smooth acerates, variable in size, becoming so short internally, (that is where they are in immediate contact with the chitinous coat,) as to be trapezoidal or like a little boat or "cocked hat," according to direction in which they are viewed; arranged tangentially, crossing each other." Carter.

Loc. River Amazons, S. A.

To the above description by Mr. Carter I am able to add but little that is positive, excepting that so far as it goes it is most accurate. Upon a leaf connected with the twig that supports a specimen of *Parmula brownii*, var., received from Dr. Rusby, I find a dozen or more gemmules, easily identified as belonging to this species. They are sometimes entirely solitary; sometimes in groups of two to four or more of varying sizes, but without other association than the intervention of some grayish sedimentary matter that has not been proven to belong to a parent sponge. In no case do I find evidences of envelop-

ing skeleton spicules, excepting that immediately under and around each gemmule it is seen to be buttressed and supported by scores of spicules of a skeleton type, resting against it at many angles, and attaching it to the supporting surface, as Mr. Carter has said. These, by the way, are obscurely microspined. The aperture of the slightly elliptical, or pro-sphæroidal gemmule, is always found at one of its poles, and is prolonged into a tubule of moderate length, provoking the comparison to a tortoise with its head protruded. The layer of gemmule-spicules is "dense" because they are not crossed but lie nearly parallel with each other as if stroked with a brush and in a nearly transverse direction, corresponding with the shorter axis of the ellipse.

The normal character of the living sponge remains, as Carter left it, an unsatisfied problem; but the absence of surrounding spicules suggests to me the possibility that the minute body of *Spongilla navicella* is simply a firmer sarcode unsupported by a skeleton frame work.

(9) **Spongilla bombayensis,** Carter. Ann. etc. 1882, p. 369.

"General form of sponge unknown. Statoblast sessile, globular, more or less grouped and firmly attached to the stems of the herbaceous plant upon which it had grown; variable in size under $\frac{1}{37}$ of an inch diameter, composed of a spiculiferous capsule, a chitinous coat, which is also spiculiferous, and the usual germinal contents, but no distinct cellular coat. Spicules of the statoblast slightly curved, thick, cylindrical, more or less obtuse at the ends; about 9 by 2–6000 ths. of an inch in greatest dimensions; and another comparatively thin, fusiform, and more or less pointed at the ends, about 10 by 1–6000 ths. inches in greatest dimensions; both thickly spined, and varying in stoutness inversely with their proximity to the surface; arranged horizontally, so that the ends do not project beyond the level of the statoblast, where they more or less cross each other and are held together by granules (the microcell structure?); appearing also in the chitinous coat when they do not cross each other but form a *single* layer, in which the spicules lie more or less parallel to each other in various directions, so as to present a damascened appearance. Skeleton spicules of one form only, viz.–acerate, curved, fusiform, gradually sharp-pointed, smooth or microspined, about 22 by 1–1800 th. inch in their greatest dimensions. Aperture of statoblast sunken, single or in plurality, lined by a tubular projection of the chitinous coat." Carter.

Loc. Island of Bombay.

(10) **Spongilla botryoides,** W. A. Haswell. Proc. Linn. Soc. N. S. Wales, 1882, p. 209.

"Sponge yellow, encrusting; skeleton spicules curved, fusiform, sparsely microspined; statoblast spicules short, strongly curved, with heads composed of numerous short, blunt or subacute spines. Shaft free from spines." Haswell.

Loc. Pond near Brisbane, Australia.

(11) **Spongilla sceptrioides,** W. A. Haswell. Proc. Linn. Soc. N. S. Wales, 1882, p. 209.

"Skeleton spicules microspined; statoblast spicules cylindrical, spined, particularly near the head."

Loc. Pond near Brisbane, Australia.

(12) **Spongilla cinerea,** Carter. Ann. and. Mag. 1881, p. 107.

"Flat, spreading; surface slightly convex, presenting gentle eminences and depressions. Color cinereous; texture compact, fine, friable. Skeleton spicule curved, fusiform, gradually sharp-pointed, minutely spined. Statoblast globular; aperture infundibular; crust thick, white, composed of microcell substance, charged with minute acerate spicules which are curved, cylindrical, abruptly sharp-pointed, and coarsely spined throughout; arranged more or less tangentially, intercrossing." Carter.

Loc. Bombay.

(13) **Spongilla fragilis,** Leidy. (Pl. V, fig. ii; Pl. VIII, figs. i, ii, iii, iv.) Proc. Acad. Nat. Sci. Phila. 1851, p. 278.

Syn.— European, See Vejdovsky, "Diagnosis." p. 176.
Syn.— American.
1863 *S. lordii,* Bowerbank.
1875 *S. ottawaensis,* Dawson.
1880 *S. morgiana,* Potts.
S. calumeti, B. W. Thomas.
1880 *S. fragilis,* var. *minuta,* Potts.
1880 *S. fragilis,* var. *minutissima,* Potts.
S. fragilis, var. *irregularis,* Potts.
S. segregata, Potts.

Sponge "discoidal, lichenoid, growing in patches flat, oval or circular, lobate at margin, translucent, yellowish white or cream colored. Areolæ distinct, subcircular. Reproductive bodies arranged in a single close layer at the base of the attachment of the sponge; shining whitish yellow, elevated into a central papilla upon the upper surface.

"*Meas.* From one half inch to two inches in diameter by one to one and a half lines in thickness at the centre and gradually thinning off to the margin.

"*Hab.* Grows upon the underside of stones below low-water mark in the rivers Delaware and Schuylkill.

"*Structure.* Composed of an intertexture of spiculæ about one four hundredth of an inch long, having a minutely tuberculated surface, over which is reflected a granulo-cellular membrane.

"*Remarks.* After the death of the sponge, the areolated tissue macerates off, leaving the reproductive bodies in a close layer attached to the rock. The living sponge is never green(?), nor does it ever grow exposed to the light."(?) Leidy.

I have thought best to preface my own description of this species as seen and collected in multitudes of localities, by the above original description by its discoverer Dr. Leidy. I append the following from my note book:—"At the Acad. Nat. Sci. January 31st. 1885—re-examined type specimen on a stone, of '*S. fragilis*, presented by J. Leidy,' taking a few spicules and statoblasts for comparison. After mounting, (Pl. VIII, fig. i,) I find the skeleton spicules average 0.0081 inches; the dermal spicules 0.0027 inches in length. One four hundredth inches as given in his description corresponds with the decimal fraction 0.0025 inches; and my measurement therefore agrees very nearly with Dr. Leidy's, of the dermal or flesh spicules. He does not describe those of the skeleton."

See further remarks as to its identification later.

I would describe it as follows:—

Sponge varying from a nearly white to a bright green according to its exposure to the light; encrusting, in subcircular patches, thin at the edges, occasionally one or more inches thick near the middle. Surface smooth or more or less tuberculated; pores and osteoles numerous; the latter sometimes one fourth inch or more in diameter at the confluence of several of the larger canals. Texture more compact than that of *S. lacustris.* (Pl. V, fig. ii.)

Gemmulæ abundant; primarily in one or more pavement layers, generally found at the base of the sponge; their foramina prolonged into tubes upon the upper or outer side; frequently curving to one side but not flaring like the funnel of a steamboat. In other positions the gemmules are found in compact groups of varying numbers; the foraminal tubules uniformly opening *outward.* (Pl. V, fig. ii, B.) In all situations they are enveloped in a parenchyma of spher-

ical cells of nearly uniform size, made polygonal by contact, charged with multitudes of spinous acerates.

Skeleton spicules slightly curved, smooth, rather abruptly pointed. (Pl. VIII, fig. i, ii, iii, iv. a, a, a.)

True dermal spicules wanting.

Gemmule spicules or those embedded in the parenchyma, (Pl. VIII, as above, b, c. etc.) either cylindrical or larger at the middle and slightly tapering toward the extremities, which are truncate, rounded or with a single terminal spine; entirely spined; spines erect, conical or rounded; generally largest near the ends of the spicule.

Approximate measurements. Diameter of gemmules 0.02 inches. Length of skeleton spicules 0.0075 inches; of gemmule spicules 0.003 inches.

Hab. Standing or running water everywhere; rather affecting the former.

Loc. In all parts of North America heard from; Europe etc.

The proper identification of this sponge which was the first described as discovered upon the American Continent, has become a subject of particular interest on account of its recent discovery at several points in the Eastern Hemisphere. The original description by Prof. Leidy has just been quoted. It will be remarked that although the date of its publication was a dozen years prior to that of Dr. Bowerbank's "Monograph" (1863) the name does not appear in his list of species. This is explained by the absence of illustrations from Dr. Leidy's text and the unfortunate circumstance (as narrated by Dr. B. in his description of *Meyenia leidyi*,) that the sponge sent to him marked "*S. fragilis*" did not correspond with the accompanying description, but proved upon examination to belong to a novel and quite different species.

Dr. Bowerbank consequently ignored *S. fragilis* as imperfectly described and was followed by H. J. Carter in a similar omission. I take pleasure in restoring the name to its proper place in the literature of the subject, associating it with the species now described for the following reasons:—

In 1878 or 1879 my attention was first attracted to the subject of fresh-water sponges by the discovery of a few gemmules, resembling a rust-colored incrustation, upon a stone from Lansdowne Run, Philadelphia. Noticing the variation of the truncate flesh spicules from the pointed acerates in the descriptions of *S. lacustris* and *S.*

fluviatilis, then only known to me, the sponge to which they belonged was, not unreasonably perhaps, supposed to be new, and the name *Spongilla morgiana* was suggested for it, (Proc. Acad. Nat. Sci. July 1880) from a fanciful resemblance of the gemmules with their upright foramina, to the jars in which the "Forty Thieves" were so neatly "done in oils" by that consummate artist. On coming to a knowledge of Dr. Leidy's description some months later, I sought and found *this* sponge in his (Dr. L's) original localities. Repeated comparison of the sponge with the above description resulted in the conviction of their entire agreement, if we regard the author as examining a mass of sessile gemmules after the skeleton spicules had been generally removed. At last a small stone was discovered in in the museum of the Philadelphia Academy, to which was attached the legend, in the author's handwriting, "*S. fragilis* presented by J. Leidy," and still bearing a few gemmules and spicules of the same species. The identification was then complete, and *S. lordii*, Bk. 1863; *S. ottawaensis*, Dawson, 1875; and *S. morgiana*, Potts 1880, became synonyms.

Next to *S. lacustris*, *Spongilla fragilis* is the most widely distributed American species; having been found in most of the United States and in all varieties of situations. It seems to grow indifferently, in rapidly flowing streams, in currentless reservoirs, and even in nearly stagnant pools. Where it is found at all, the specimens are usually abundant. Upon one occasion when the water was withdrawn from the canal basin at the head of the locks at Fairmount Dam, Philadelphia, the exposed, perpendicular walls of dressed stone were seen to be lined with them, probably hundreds in number; some of minute size, but many covering two or three square feet of surface. They were rarely much more than an inch thick near the middle and shaded off all around to filmy edges. They had no apparent preference for the comparatively rough surface of the stones, for some of the finest specimens were found upon the timbers of the gates, from which they were easily removed.

The large size of the efferent osteoles in this species is a conspicuous feature; and within each of them can be seen the terminations of five or six of the larger canals. When mature, say in August or later, the pavement layer of gemmules may generally be found at the base of such specimens; and in those still older, the segregate or grouped forms are frequently abundant in the higher parts of the sponge.

These *groups* were not observed or described by Dr. Leidy, and when first noticed by myself were supposed to indicate either a new species or variety; but it was long ago discoverd that to a greater or less extent they formed a characteristic feature of *all types* of *Spongilla fragilis.* It has seemed to me that while the "pavement layer" of gemmules was firmly attached to its base of support, indicating a purpose to reproduce the sponge at the *same* place, the *groups*, which are not so attached, and are liberated by the sloughing away of the skeleton spicules during the winter season, float off and serve to propagate the species in *distant localities.* They must not be understood to be merely accidental collections of gemmules in the same neighborhood and without coherence, (as is the case with those of *S. aspinosa*); but to be closely and permanently associated and embedded in a mass of compact "cell-structure"; (the "cellular crust" of Carter, the "external parenchyma" of Vejdovsky); sometimes but three or four together, (Pl. V, fig. ii, B.) compared by H. J. Carter to the tetraspores of *Selaginella*;—sometimes a dozen or more, very irregularly grouped, but *always* with their foraminal tubules projecting *outward* through the crust; in which vast numbers of spined spicules are embedded.

The spicules of this class are very variable in shape in the different localities in which this species has been found; being long or short; robust or slender; truncate or pointed; while the *general* characteristics of the species remain unquestionable. A few varieties that appear constant have been named. Upon nearly every slide of prepared gemmules or spicules may be seen a few abnormal, spherical forms, bristling with spines, and reminding one of the pollen of Malvaceous plants, or the "caltrops" in sometime military use.

S. fragilis, (*S. lordii*, Bowerbank.) Syn. Proc. Zool. Soc. 1863.

Dr. Bowerbank's description is here copied for convenient reference. The species would have been "good" in his name had it not been antedated twelve years, by Dr. Leidy.

"Sponge sessile, coating; surface even, smooth. Osculæ simple, dispersed. Pores inconspicuous. Dermal membrane pellucid, aspiculous. Skeleton spicula acerate. Ovaria congregated on the basal membrane, very numerous; spicula entirely spined, fusiform-cylindrical, dispersed on the surface. Basal membrane abundantly spiculous; spicula dispersed, same as those of the ovaries. Color ochreous yellow to green."

Spongilla fragilis, (*S. segregata*, Potts.) Syn.

My error in separating this form has been acknowledged.

S. fragilis, (*S. calumeti*, Thomas.) Syn.

This form has very robust gemmule spicules. (Pl. VIII, fig. iii.)

S. fragilis, var. **minuta**, Potts. (Pl. VIII, fig. iv.) Proc. Acad. Nat. Sci. 1880 p. 357.

This varietal name was given to a sponge first found at Lehigh Gap, Pennsylvania, in which the gemmules were much smaller than in the typical form, while the surrounding spicules were nearly double the length of those of the same class in it and were nearly always terminated by a single sharp spine. It has since been found at several other localities.

Meas. Skeleton spicules 0.01 by 0.0004 inches. Gemmule spicules 0.00463 by 0.00025 inches.

S. fragilis, var. **minutissima**, Potts. (Pl. VIII, fig. ii.)

The gemmules of var. *minutissima* are still smaller than those of var. *minuta*; the groups consist of greater numbers of individuals; the cell-structure surrounding them is still coarser and more conspicuous. The skeleton spicules of those collected in Lake Hopatcong, New Jersey, (alt. 1200 ft. above tide.) are very slender and although gathered in October often centrally inflated.

Meas. Skeleton spicules 0.0064 by 0.00015 inches; gemmule do. 0.00397 by 0.0001 inches.

S. fragilis, v. **irregularis**, Potts.

In this, which was also collected at Lake Hopatcong, the skeleton spicules are short and slender; gemmule spicules irregularly bent and inflated.

Meas. Length of skeleton spicules 0.0042 inches; of gemmule do. 0.003 inches.

(14) **Spongilla igloviformis**, Potts. n. sp. (Pl. V, fig. iii. Pl. VIII, fig. v.)

Sponge light or dark brown, encrusting, thin; surface somewhat corrugated, or smooth, excepting the projecting points of spicules. Lines of skeleton spicules much dispersed, forming no recognizable intertexture; the sarcode in this species being at its maximum, in relation to the skeleton spicules, which are seen at their minimum as to numbers.

Gemmules very numerous, in compact groups of eight or ten to twenty or more; irregularly disposed upon, but not attached to, the

supporting surface. These groups are approximately hemispherical in shape, resting upon a flat subcircular side or base, above which they form a dome-shaped mass suggesting a resemblance to the *igloe* or hut of an Eskimo (Pl. V, fig. iii, A.). The foraminal apertures of the gemmules composing these groups, contrary to their uniform habit in *S. fragilis*, *all open inward*, apparently communicating with a central cavity within the mass or group. Each gemmule, as in the last named species, is enveloped in a cellular parenchyma, which also, by short isthmus-like bands, connects it with the adjoining gemmules and finally compacts the members of a group together; but, whereas the parenchymal cells of *S. fragilis* are nearly uniform in size, these are very variable, being large upon the superfices of the gemmule proper and upon the outer surface of the envelope; while the interior cell-structure is with difficulty resolvable under a one-fifth objective. This parenchyma is densely charged with echinating spicules.

Skeleton spicules very few, sub-fusiform, but somewhat enlarged *near* the terminations, then abruptly pointed or rounded; sparsely microspined; spines short, obtuse. (Pl. VIII, fig. v, a.a.)

Gemmule spicules exceedingly numerous, nearly as long as those of the skeleton; sub-fusiform, abruptly pointed, entirely spined. Spines long, acute; perpendicular at the middle of the spicules while those near either end are strongly recurved. (Pl. VIII, fig. v, b.b.)

Meas. Skeleton spicules 0.0099 by 0.0004 inches; gemmule spicules 0.00657 by 0.0004 inches.

Hab. Upon the lower side of timbers etc. in Cedar swamps near the East coast of New Jersey.

Loc. Collected as yet only near Absecum and Vineland N. J.

The points of difference between this species and *S. fragilis* seem obvious. I find them in the spinous character of the skeleton spicules; in the want of fibrous structure in the sponge itself; in the different characters of the gemmule spicules; in the absence of a pavement layer of gemmules; in the peculiar flat-sided arrangement of the groups and in the fact that the germinal apertures all open inward.

This sponge was discovered during a memorable visit to Doughty's Pond, Absecum, New Jersey, December 1st. 1883. The lo ity l been described in the general remarks under the head of

aspinosa. Just before leaving the place, happening to draw up a submerged slab lying in shallow water near the saw-mill, I found, irregularly scattered upon its under side, a quantity of large, light-colored particles, disconnected from any noticeable sponge growth, and looking suspiciously like large grains of sawdust. They were so much larger than ordinary statoblasts, that, not delaying to examine them minutely, I filled one or two bottles on "general principles" merely and took them with me. My pleasure in examining them after reaching home and chagrin at the recollection that, contrary to my usual custom, I had left the slab half drawn out of the water, was such that I wrote by the next mail to the proprietor of the mill, requesting him to restore the timber with the remaining embryos to their native element. On two subsequent visits I was successful in finding and collecting growing sponges of this species, exhibiting the peculiarities described in the technical part of this description.

From a somewhat similar pond in the neighborhood of Vineland N. J. my friend U. C. Smith Esq. has, on two occasions, brought me gemmules of the same species.

From MacKay's Lake, near Pictou, Nova Scotia, Mr. A. H. MacKay has kindly sent what seems to me the same or a nearly related species, which was described a year later by Mr. Carter under the name of

(15) **Spongilla mackayi,** Carter. Ann. and Mag. Jan. 1885, p. 19.

"Sponge sessile, spreading; charged with little sub-globular bodies, like large statoblasts, about one twelfth inch in diameter. Skeleton spicules acerate, slightly curved, sharp-pointed, more or less thickly spined; averaging 50 by 2½–6000ths. inches in their greatest dimensions. Statoblast globular, consisting of a thick chitinous coat filled with the usual germinal matter, from which is very slightly prolonged an everted trumpet-shaped aperture; bearing slight traces externally of microcell-structure and the polygonal tissue; making one of twenty such which are so arranged as to form a sub-globular body of the size mentioned; situated around a central cavity with their apertures *inwards*; the whole supported by statoblast spicules of various sizes, which, intercrossing each other form a nest-like globular capsule in which the outer parts of the statoblasts are fixed and covered; apparently, (for the specimen is dry) deficient at one point, which leads into the central cavity. Statoblast spicules acerate, sharp-pointed like the skeletal spicules, but becoming much shorter

and more coarsely spined as they approach the chitinous coats of the statoblasts, where they may be reduced to at least $\frac{27}{6000}$ ths. inches in length, although often increased to $\frac{1}{6000}$ ths. inches in thickness, and their spines, which are very irregular in size and situation, often as long as the spicule is broad." Carter.

Loc. MacKay's Lake, near Pictou, Nova Scotia.

(16) **Spongilla böhmii,** Hilgendorf. Ann. and Mag. N. H. Vol. XII, 1883, p. 122.

"Sponge parasitic upon masses of *Spongilla nitens,* appearing as an inconspicuous crust of only one millimetre in thickness; consisting of a very fine-meshed, delicate frame work. The magnificent gemmulæ are grouped in a single layer of from 8 to 12 within the skeleton, but at the same time much projecting from it; always very few in number.

"A delicate homogeneous lamella sharply divides the two species.

"The skeleton spicules are similar in form to those of *S. nitens,* but are only half their length, and instead of being smooth are studded with roundish, flattened tubercles, which at the ends approach considerably closer together.

"They are accompanied by a four times smaller amphidiscoid form, whose shaft is gently curved and bears at some distance from the the centre a small spherical elevation. From a similar one at each end of the shaft proceeds five short, pointed, recurved prongs, exactly as in a whorl. These double whorls lie close to the large spicules and form with them the network, the threads, of which are mostly but one spicule in thickness.

"The gemmulæ have not the layer of parenchyma; the spicules lie tangentially and in only a single layer; but they are densely crowded and at the same time minute; so that their number is very considerable and may exceed a thousand in one gemmule. Each spicule is moderately curved, cylindrical, with only the last eighth or tenth tapering to a point. The surface bears a moderate number of short acute spines; say 50 on the entire spicule." Slightly abbreviated from M. Hilgendorf.

Loc. River Ugalla near Lake Tanganyika, Central Africa; collected by Dr. R. Böhm.

Through the good offices of my friend Mr. Carter and the kindness of Dr. Weltner, of Berlin, I have been favored to receive from Dr. Hilgendorf of the Berlin Zool. Museum, where it was deposited, an excellent specimen of *S. nitens,* bearing upon one of its surfaces a

film of the above *S. böhmii*, ample for comparison with the next species, *S. novæ terræ*, which, in one point, it most curiously resembles. Having given above the very clear description by Dr. M. Hilgendorf, it is needful only to explain that while *such* a "layer of parenchyma" around the gemmule as that seen in its associate species, *S. nitens*, is absent, the gemmule of *S. böhmii* is provided with a thick "granular crust" beneath which the gemmule spicules are embedded, a capsule of skeleton spicules enveloping the whole. The dermal or flesh spicules, as he describes them, are minute *birotulates*, nearly resembling those of *S. novæ terræ* and *Meyenia everetti*, but somewhat larger than either: the shafts are more frequently bent and a bolder enlargement at each extremity gives origin to more widely spreading hooked rays. I incline to the opinion that the occasional inflations of the shafts of these spicules as well as of the spicules of the gemmule, indicate a want of full maturity in the specimen when gathered.

My interest in the description given of this little species by Dr. Hilgendorf was such as to induce me to ask, through Mr. Carter, the opportunity of making a personal examination of it; more particularly, to discover whether in it, as in *S. novæ terræ*, the birotulate dermal was associated with a gemmule acerate showing any tendency toward a birotulate form. This I find is no more the case than in several other species of *Spongilla*; *S. fragilis* for instance, where there is also a grouping of recurved rays *near* the extremities.

The curious fact that a coincidence of type has here associated the Island of Newfoundland with Central Africa, will not escape the notice of any one; nor that a corresponding form in a neighboring genus should only appear, as yet, in places so remote as a corner of Massachusetts and the Lakes of Nova Scotia.

(17) **Spongilla novæ terræ**, Potts. Proc. Acad. Nat. Sci. Phila. 1881, p. 228 etc.

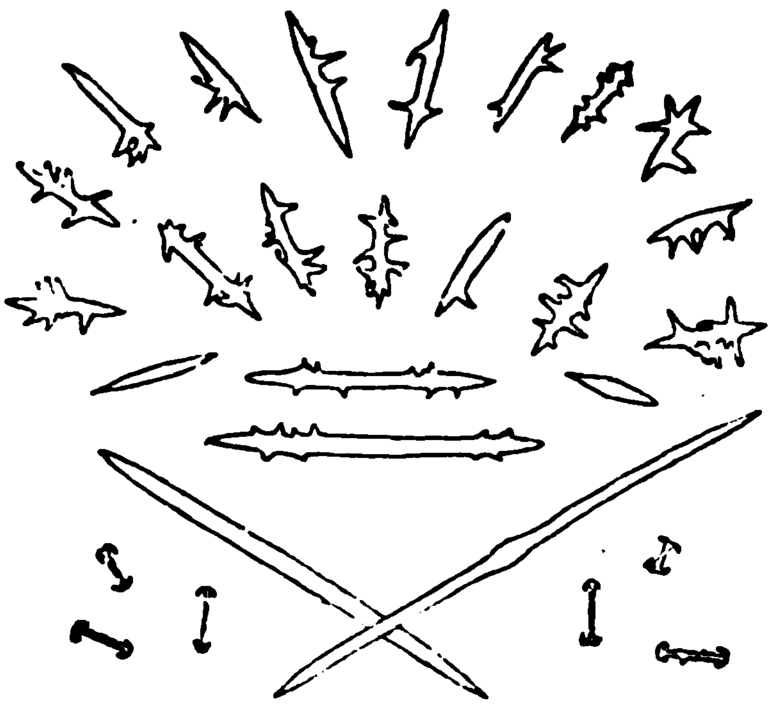
Sponge encrusting; sarcode of the young growth, a dense mass of minute spherical cells, embedding slender, curving lines of fasciculated skeleton spicules, developing later into a very loose, open tissue, with few connecting spicules.

Gemmules rather numerous, unusually large, spherical; chitinous coat thin; crust apparently wanting.

Skeleton spicules relatively few, slender, cylindrical, smooth or sparsely microspined; gradually pointed. (See cut.)

Dermal or flesh spicules very abundant, minute *birotulates* of unequal size; shafts slender, cylindrical, occasionally spined; outer

surface of rotules dome-shaped; rays prolonged, terminations acute; malformations frequent. These are mixed with occasional linear spined spicules.



Gemmule spicules abundant, crossing each other upon the crustless, chitinous body. Their shape when smooth is robust-fusiform, with pointed terminations: the great majority, however, have from one to six or more long spines, non-symmetrically placed, but with an evident tendency to group themselves at points about one-fourth the length of the spicule from one or both of its extremities.

Meas. Diameter of gemmules 0.036 inches; skeleton spicules 0.0068 by 0.0002 inches; length of average dermal birotulate, 0.00066 inches; and of those of the gemmulæ 0.00145 inches.

Hab. Encrusting stones in shallow water.

Loc. Lakes or ponds in the vicinity of Heart's Content, Newfoundland; collected by Mr. A. H. MacKay.

As the unusual features of this sponge give it a peculiar importance, I am tempted to copy the results of an entirely independent study of it by my friend Mr. Carter, taken from a letter written to the discoverer, Mr. MacKay. The comparison of it with that above given may be both interesting and instructive, as showing how the same peculiarities, equally new to both, may impress different observers.

"Specimen sessile, spreading over two sides of a cubic stone about two inches in diameter; about one sixth inch high in the center, thinning off towards the circumference. Color of the surface greenish; of the interior greyish brown. Surface smooth, shining, (in the dried state), covering a parenchymatous structure beneath, traversed by thread-like bundles of the skeletal spicules of the species, charged with statoblasts.

Statoblasts globular, of different sizes, but comparatively large generally; being often $\frac{225}{6000}$ths of an inch in diameter; covered in a tessellated manner, by a single layer of short fusiform spicules in juxtaposition and all on the same level.

Fusiform spicule short, thick and smooth fundamentally, averaging 10 by 1-6000th. inch in its greatest dimensions, but variable in length, presenting one to twelve spines most whimsically scattered over the surface, so that no two spicules are alike in this respect. Aperture of the statoblast single, circular, slightly marginated, about $\frac{9}{6000}$ths. inch in diameter.

Skeletal spicule slightly curved, smooth and gradually pointed comparatively small, forming, by overlapping each other linearly, the thread-like bundles mentioned; about 40 by 1-6000ths. inch in its greatest dimensions,

Dermal layer and tissue generally abundantly charged with minute birotulates, almost identical with those of *Meyenia everetti*, but a little larger and with longer and more recurved teeth at the terminations: about $\frac{5}{6000}$ths. inch in length."

Loc. Heart's Content, Avalon Peninsula, Newfoundland.

All the specimens of this sponge came from the neighborhood of Heart's Content, but whether they were gathered from a lake upon the heights or from a brook, mentioned by Mr. Mackay, near the sea level, does not seem entirely clear. The accompanying illustration, magnified 225 diameters will suggest the peculiarities of its skeleton (crossed below), dermal (at lower corners) and gemmular spiculation (above). The striking resemblance (alluded to by Mr. Carter), of the dermal spicules to the minute birotulates, heretofore only known in a corresponding position, in the cases of *Meyenia everetti* and *Spongilla böhmii*, will at once impress the student. These are however more variable in size, are occasionally spined, and have their rays more prolonged and more delicately terminated.

It is in the singular character of the spicules surrounding the gemmules that this species must attract peculiar attention. As the reader must already have discovered, the six genera included in Carter's system may be divided into two principal groups; one of them including only the genus *Spongilla*, characterized by the *linear*, *acerate* spicules surrounding the gemmules; and the other, comprising all the other genera, where the spicule of corresponding significance is a *birotulate* or some easily recognized derivative of that type. Within this latter and larger group, intermediate forms, connecting the defined genera, are frequent, and the location of species upon one side or other of the distinctive line, comparatively unimportant. Heretofore, between the genus *Spongilla* and those genera comprised in the other group there has been "a great gulf fixed." One only

case in the past has suggested their possible association, or the development of one group from the other.

By referring to the description of *Meyenia fluviatilis*, var *acuminata*, mihi, it will be seen, that in that variety, the shafts of the birotulates are prolonged at each extremity, forming acuminate terminations some distance beyond the surface of the rotules. It must be noticed also, that in position these spicules are abnormal, lying flat upon the chitinous coat, instead of resting upon one rotule, their shafts taking the position of radii, as is usual in this genus. We have here in fact spicules of a *Meyenia* occupying the ordinary positions, and in degree approximating the forms of those regarded as peculiar to the *Spongillæ*.

In the present species the intermediate character of the gemmule-spicules is still more striking; and while their form and position probably more closely associate them with the genus *Spongilla*, in which I have, after considerable hesitation, placed the species, the grouping of ray like spines is forcibly suggestive of *Meyeniæ*; it will be therefore no cause for surprise, if further examination shall cause its transfer to the sister genus.

It must not escape notice that in both of these instances the gemmulæ are without "crust," and as it is difficult to understand how birotulates could be supported in their *ordinary* positions without these embedding granules, we may not unreasonably infer a possible relation of cause and effect between the change in position, and the modification of type that we here find.

As this is the first novel species of fresh water sponge collected upon the Island of Newfoundland, as also, this is the highest latitude in North America from which any collections have been recorded, it may be well to append to the above, in which the original report to the Proc. Acad. Nat. Sci. (1886) has been closely followed, the remarks of Mr. MacKay, as to the extremes of temperature etc. in that region.

He says: "The Island is not extreme in its temperature, and the frost does not go very deep into the soil. The lakes freeze in November or December with ice at least a foot in thickness, and remain closed until the end of April. The average temperature during eight years, from 1857 to 1864, was 41.2° Fahr.: average maximum thermometer during the same time 83°; mimimum, 7°. In the year 1879, the mean temperature was 40.2° Fahr; highest record, August 3rd, 82°; lowest, December 22,+4°. In Nova Scotia,

though that is so much further south, the range is far greater, from +96° to —20° or —24° Fahr.; with an annual average of 44°."

(II) **Gen. MEYENIA, Carter**, Ann. and Mag. etc. 1881, p. 90.

Gen. Char. Skeleton spicules acerate, curved, fusiform, pointed or rounded, smooth or variably spined. Gemmules globular or oval, enveloped in a granular crust, charged with birotulate spicules (Pl. IX, b. b. etc.) of a single class or type, radially arranged; *i. e.* with one rotule resting upon or approximating to the chitinous coat, the shaft erect and the other rotule forming, or projecting beyond the surface of the gemmules. (Pl. V fig. v and vi.)

The existence of birotulate spicula (then called amphidisks) in the crust surrounding the gemmulæ of some sponges was first pointed out by F. J. F. Meyen, (1839) who made them the distinctive characteristics of *Spongilla fluviatilis*; thus distinguishing that species from *S. lacustris*, with which until that time it had been constantly confused. In his generic revision of the group, finding that several species possessed the same peculiarity, Mr. Carter, with excellent taste, grouped under the name of Meyen those that exhibited this feature in its simplest conditions.

Next to *Spongilla* in importance, as it follows it in our classification, the genus *Meyenia* appears to be the most widely diffused throughout the world; and its leading species, *M. fluviatilis*, like *S. lacustris* is found exhibiting many variations, to perplex the student and tempt him to the creation of unnecessary names. The following is presented as a guide to the approximate determination of the several species.

KEY TO THE SPECIES OF THE GENUS MEYENIA.

(*a*) *Margins of birotulate spicules entire.*

1. Skeleton spicules covered with powerful spines. Spool-like birotulates upon the surface of the gemmulæ covered with a deep parenchyma of large cells.
Meyenia, (*Trochospongilla*) *erenaceus.*
2. Skeleton spicules *smooth*, short, robust; margins of short birotulates *exflected*; each gemmule enclosed in a capsule of skeleton spicules. (Pl. V fig. iv, Pl. X, fig. i.) *M. leidyi.*
3. Rotulæ *large, flat*; gemmules furnished with an envelope charged with *spined spicules.* *M. gregaria.*
4. Gemmules about one fourth the size of those of other species.
M. minuta.

(*b*) *Margins of birotulate spicules rayed.*

5. Skeleton spicules either smooth or microspined; dermals wanting; birotulates short, shafts generally smooth; margins of rotules irregularly rayed. (Pl. V fig. v; Pl. IX figs. i, to iv.) *M. fluviatilis.*
6. Birotulates in two or three series. *M.* (*Ephydatia*) *mülleri.* (See also genus *Pleiomeyenia.*)
7. Parasitic on *S. lacustris*; foramina funnel shaped. *M. bohemica.*
8. Birotulate spicules generally malformed; shafts with enormous spines, etc. (Pl. IX fig. v.) *M. robusta.*
9. Birotulates rather long, shafts smooth; margins of rotules lacinulate. (Pl. X fig. ii.) *M. millsii.*
10. Rays and spines of birotulates subdivided or microspined. (Pl. IX fig. vi.) *M. subdivisa.*
11. Dermal spicules with long, erect spines; birotulates long, spined; rays incurved. *M. baileyi.*
12. Birotulates rather long; margins crenulate or granular. *M. capewelli.*
13. Gemmules flask-shaped; apertures terminal; birotulates very short, obscure. *M. anonyma.*
14. Shafts of birotulates much spined. *M. ramsayi.*
15. Birotulates many times longer than the diameter of the hooked rotules; shafts spiniferous. (Pl. V, fig. vi. Pl. X, fig. v.) *M. crateriformis.*
16. Gemmule birotulates long, club-like. Dermal spicules also *birotulate*, minute. (Pl. X, fig. iii and iv). *M. everetti.*
17. Gemmule birotulates long, spinous; margins of rotules notched: dermal spicules stellate. (Pl. X, fig. vi.) *M. plumosa.*

(*a*) *Margins of birotulate spicules entire.*

(1) **Meyenia (Trochospongilla) erenaceus,** Ehrenburg, See Vejdovsky's "Diagnosis." p. 177

In his description Prof. Vejdovsky has not, I think, invested the parenchyma surrounding the gemmulæ of this species with sufficient importance. From specimens which he has kindly sent to me, I am led to regard this feature, at least to this degree, as unique amongst the sponges, and I regret my inability to furnish an illustration of it. I do not know whether the sponge mass bears any external resemblance to that of *M. leidyi*, but they are unquestionably distinct species.

(2) **Meyenia leidyi,** Carter. Ann. and Mag. 1881, p. 91. (Pl. V, fig. iii. Pl. X, fig. i.)

Spongilla leidyi, Bk. (Proc. Zool. Soc. 1863, p. 445 etc.)

"Sponge sessile, coating, thin; surface tuberculated, minutely hispid; oscula numerous, small, congregated, elevated and marginated; pores conspicuous. Skeleton spicula acerate, small, short and stout, rather obtusely terminated. Dermal and interstitial membranes aspiculous. Ovaria spherical, small; dermal spicula birotulate, minute, short; shaft cylindrical; rotulæ margins entire, that of the outer one sometimes exflected and rarely spiculated."(?) Bowerbank.

The above is Dr. Bowerbank's original description after the examination of one dry specimen. During the past six years I have collected the species, scores of times and perhaps in greater quantity than any other. I will describe it as I have seen it.

Sponge of a peculiar light gray or drab color, even when exposed to the light; encrusting, thin. *Persistent;* the growths of successive seasons forming as many series of thin lamina. Surface even, sometimes rising into smooth rounded prominences, and at times covered with singular radiating or bird-track-like markings, whose cause is not fully understood. Pores and osteoles numerous, minute; the latter being found along the radiate lines, but not conspicuously at their confluence. Texture very compact; composed of short spicules, very slightly fasciculated; the primary lines and principal channels nearly perpendicular; with single intercalating spicules forming polyhedral interspaces.

Gemmules numerous, sub-spherical, deposited at the base of the sponge and, in successive seasons, in serial layers above (or below?) the first. Each mature gemmule is surrounded, outside of the birotulate armature, by a lattice work or capsule, composed of spicules resembling those of the skeleton; an open space being left at the top around the short, tubular foramen (Pl. V, fig, iii, A). When more than one of these is present, they are grouped together, and the open space of the capsule is correspondingly enlarged. Before maturity a granular crust embeds and surrounds the dense layer of short birotulates, but after the latticed capsule is formed, (at least when examined in a dry state) I have not been able to discover it.

Skeleton spicules short, smooth, robust; when mature very abruptly terminated, almost rounded. (Pl. X, fig. i, a,a,a,b,b.)

Dermal and interstitial surfaces aspiculous.

Birotulate spicules surrounding the gemmules very short, umbonate; rotules sometimes twisted or contorted; margins entire; generally exflected or turned up saucer-like, away from the surface of the gemmule; the diameter of the outer rotule generally rather less than that of the proximal one. (Pl. X, fig. i, c,d, etc.)

Meas. Skeleton spicules 0·00466 by 0·00045 inches. Length of birotulates 0·00045 inches. Diameter of large rotule 0·00055 inches, and of shaft 0·0001 inches.

Hab. Encrusting timbers and stone work at various, probably sometimes at great, depths.

Loc. Found as yet only in the Schuylkill River and reservoirs near Philadelphia; at Windmill Island in the Delaware River; and near Phillipsburg, New Jersey.

Several circumstances give to this species of fresh water sponge peculiar interest and importance. Described at first from a specimen inadvertently sent by Prof. Leidy to Dr. Bowerbank, as mentioned by the latter in his "Monograph," (Proc. Zool. Soc. 1863, p. 445) and already alluded to in my historical sketch of *Spongilla fragilis*, it appears to have remained unseen and uncollected from 1863 until 1880 when the writer rediscovered it at the original locality,–the neighborhood of Fairmount Dam on the Schuylkill River, Philadelphia. I am not aware that any has been found elsewhere, excepting at Windmill Island in the Delaware River, near by, and a single dry specimen, origin unknown, upon a stick which I picked up upon the bank, high above the Delaware River at Phillipsburg, New Jersey.

Fairmount Dam, just mentioned and frequently referred to in these pages, is, of course, already known to Philadelphians; but as it has been spoken of as one of the richest localities in the world for fresh water sponges, a brief description of the situation may be allowed, for the information of others. It is situated at the head of tide water in the Schuylkill River within the limits of the City of Philadelphia. It supplies upon one side, a system of locks pertaining to the Schuylkill Navigation Co. and on the other, pours its living floods through the magnificent turbine water wheels, by which the pumps are operated, that raise a large portion of the water-supply of the City to the subsiding and distributing reservoirs upon the summit of the neighboring Fairmount Hill. The direction of the dam breast is not at right angles to the course of the stream, but follows a line of rocks diagonally toward the northwest, turning

abruptly to the southwest, when one or two hundred feet from the heavy masonry of the canal locks.

The exposed portions consist of heavy timbers and planking; the top and a lower section being horizontal or nearly so, connected by an inclined slide or shoot. To increase the depth of the water above the dam, for the benefit of the Philadelphia Water Works, a series of planks have been hinged to the upper, horizontal portion, and are retained in a perpendicular position, by inclined stays or props. When the river is full, the water stands against these and overflows them, nearly two feet above the normal level of the dam. During the summer season, however, the diminished supply is so drawn upon by the operation of the canal locks, the water works and ordinary leakage, that there is rarely any overflow for several months together. At such times it has been my custom frequently to walk from one side of the river to the other upon the horizontal timbers, examining at leisure the inner (upper) side of this planking; and my collections have principally been made from their smooth surfaces, when, illuminated by the afternoon sun, every adherent growth was easily seen through the unruffled surface of the water. Not that the stream is perennially unruffled by any means, for at its best the wave from a passing steamboat is likely to flood the unwary scientist at an unexpected moment. I only allude to this quiet hour, with the declining sun nearly in front of the explorer, as presenting the most favorable conditions for collecting. Upon a single visit, I have gathered from these timbers, specimens of *S. lacustris*, *S. fragilis*, *M. leidyi*, *M. fluviatilis* and *M. crateriformis*, with minute portions of *H. argyrosperma*. The first three may be considered permanent inhabitants of the locality, the others as occasional visitants.

In the forebay of the water works and in the reservoirs above, *M. leidyi* is very abundant, covering all standing timbers, horizontal pipes and frame work, as well as the dressed stone facings of the piers etc. In tide water in both the Schuylkill and Delaware Rivers, it is found at the greatest depth examined, say eight feet below low water, and probably grows much deeper; while most of our other sponges seem to prefer the neighborhood of the surface. In the subsiding reservoirs upon Fairmount Hill and in other places about Philadelphia, it especially affects the cribs and screens at the head of the discharge pipes. When the water has been drawn off for cleaning I have found it covering yards of surface at such places,

though it rarely attained an inch in thickness. One such locality is particularly remembered,-the so-called Corinthian Avenue reservoir, which had not been emptied for several years; here the finest specimens might have been gathered, literally "by the bushel," and probably one half that measure was taken away in great slices or "slabs" under my arm.

These masses were almost certainly the results of many years undisturbed growth. I have described this species as persistent, to a degree unknown and almost impossible to imagine, in the case of any other North American sponge. The compactness of its skeleton texture is such, that, except in the event of actual violence, such as the pressure of ice etc., I do not believe that the spicules slough away during the winter, as do most of the others. Its gemmules, therefore, are rarely liberated, and the species in consequence is not largely diffused.

Transverse sections through the masses alluded to, show an upper or outer layer, about one eighth inch in thickness, of skeleton spicules in their normal positions, as formed; and below them a series of rather irregular lamina, composed almost entirely of gemmules, within their specialized lattice capsules.

The years of occasional study already given to this species leave several problems yet unanswered; prominent among which, is that of the order of these serial growths; which I must refer to my more successful followers. My difficulty may be stated thus. Let us suppose a sponge of this species, at the end of its first season's growth. It then, undoubtedly, consists of a layer of gemmules, surmounted by a film of skeleton spicules. There is reason to believe that little of the latter will be washed away during the winter season, but when spring comes, the contents of the gemmules, escaping through their foraminal orifices will probably(?) reclothe the naked skeleton (realizing Ezekiel's vision of the dry bones,) secrete fresh silica and at a slow rate continue the growth of the mass.

As the next season of hybernation arrives, what must happen? A second layer of gemmules will be deposited; but where? It does not appear to be at the summit of the sponge of the first season; for our section, in that case, would show a regular alternation of gemmules and of skeleton spicules in position. Is the second layer, then, formed above the first of the series of gemmules or below it? That is, in my fragment, now probably ten or twelve years of age, are the most recent gemmules highest or lowest in the series? I

confess my inability, as yet, to answer the question. If freshness of appearance is taken as a guide, the latter seems the more probable supposition. Numbers of gemmules without capsular covering are to be found in both situations and the foraminal openings, which may be said to be generally upon the upper side, are found in some parts of the series upon the lower. The problem remains open.

The peculiar markings upon the external surface of the sponge, form another perplexing feature. Upon other sponges we see the terminations of submerged canals, partially exposed by the rupture of the thin dermal film which alone covered them; here, the markings consist of spicular ridges, sometimes slightly grooved along their summits, and terminated at their divergent extremities by inclined efferent (or afferent?) orifices. Those who are familiar with the appearance of young, living sponges of other species, will remember that the dermal film is supported upon the points of projecting spicules, at some distance above the denser mass of the sponge, which it thus "tympanizes," to use a happy expression of Mr. Carter. The vestibule thus formed in or around them, is, in *M. leidyi*, probably on account of the shortness and non-fasciculated character of its spicules, almost or entirely wanting, and its place seems to be supplied when alive by the formation along the above-mentioned ridges, of external, sub-cylindrical, convergent canals that have not been mentioned in any other species. Upon the only occasion in which I was able to experiment upon a living sponge in this condition, I was puzzled to see the particles of carmine used in feeding it, drawn through the pores into these channels and presently sucked downward into the body of the sponge, instead of being borne forward and thrown out from them through a common orifice or chimney, as is familiar in other cases. Attempting no explanation of this reversal of ordinary methods, I merely record it as an exceptional fact.

Within some fragments collected at Windmill Island, were found many subspherical masses, like large shot, each containing three or four gemmules, embedded, not in parenchymal cells, but in a dense mass of skeleton spicules. These have not been seen elsewhere.

Some question has been raised as to the presence, in parts of this species, of spined skeleton spicules. As the result of a careful examination of large numbers of specimens I may state my belief that any such appearance has been due to the accidental intrusion of

skeleton spicules of *Tubella pennsylvanica*; which species has frequently been found in contact or in close proximity with the other.

A singular effect upon the spicules of this sponge, produced either by a retardation of their growth, or a hastened disintegration, was noticed (Proc. Acad. Nat. Sci. 1884, p. 184) in the case of fragments that had grown within certain old water pipes, and were, at the time of examination, strongly marked by iron rust. A central canal here occupied fully one half the width of the skeleton spicules and was open at both extremities; and the birotulates had lost their "entire" margins and appeared delicately rayed.

It may be mentioned in this connection, that this species, more frequently than any other, has been found encrusting iron water pipes; their exteriors, when they have long lain exposed to the water; and the interiors of those of large size, to a distance of some hundreds of feet from the reservoirs, where they had grown of course, in entire darkness. I have not yet succeeded in finding either the sponge *in situ*, or its detached spicules, among the concretions that occasionally entirely close the water-way of some of the smaller pipes, near the centre of our city.

(3) **Meyenia gregaria**, (**S. gregaria**) Bk. Proc. Zool. Soc. etc., 1863 p. 452.

"Skeleton spicula cylindrical, stout and rather short. Ovaria furnished with an envelope, spicula of the envelope few and scattered, cylindrical, short and stout, entirely spined. Ovaria, surface even, furnished abundantly with very short birotulate spicula; rotulæ flat, margins entire, outer surface umbonate; umbo very short, slightly convex. Shaft of spiculum cylindrical, short and stout. Color in the dried state dark, lurid green." Bowerbank.

Hab. "River Amazons, on branches of trees, periodically pendant in the water; near Villa Nova."

I have been able to identify several small groups of gemmules of this species on the stem of a twig supporting a mass of *Parmula brownii*, var. from Beni River, East Bolivia. As in this situation I have been so fortunate as to find and determine positively the spicular skeleton of the sponge itself which neither Dr. Bowerbank nor H. J. Carter had done, the following is offered as a complete description. It will solve some doubts of both the former authors.

Sponge minute, encrusting, thin; surface even; orifices very numerous, large. Skeleton spicules not fasciculated, consequently no long lines of fibre, the spicules attached and crossing one another in every direction.

Gemmules ovoid, rather numerous, approximating to one another in groups of varying numbers, surrounded upon the upper side by a rather sparse capsule of skeleton spicules, which become very numerous below, particularly around the circumference, where they buttress and elevate the gemmule above the firm basal membrane of the sponge. Foraminal apertures uniformly downward. The chitinous coat is covered by a very thin crust in which a compact series of short birotulates is embedded.

Skeleton spicules cylindrical, short and rather stout, slightly and nearly uniformly bent; terminations rounded; entirely spined; spines, low-conical, acute, more conspicuous upon the outer curves of the spicules.

No dermals seen.

Gemmule spicules birotulates with entire circular margins and extremely short shafts; rotules flat.

Meas. Average length of skeleton spicule about 0·0036 inches. Diameter of rotules 0·00045 inches; height of birotulate 0·0002.

Loc. Beni river, East Bolivia; collected by Dr. H. H. Rusby.

(4) **Meyenia minuta**, n. sp.

Sponge as seen minute, encrusting, relatively compact; the spicules non-fasciculated and without definite arrangement.

Gemmules in the dried state faintly suggested by the curvatures of the upper surface of the sponge; rather numerous, spherical, very small, (about one fourth the average diameter of those of other species), a thin granular crust embedding birotulates that are no smaller than those of the three previous species.

Skeleton spicules slender, cylindrical but gradually sharp-pointed entirely spined; spines conical, acute.

Dermal or flesh spicules wanting.

Gemmule-birotulates short, shafts smooth, thinnest at the centre; rotules nearly equal; margins entire, slightly reflexed, more particularly that of the outer rotule which thus becomes cup-shaped.

Meas. Diameter of gemmules about 0·005 inches; a line of ten or twelve of its birotulates only, being found along its semi-equator.

Hab. Found encrusting a leaf belonging to the stem upon which a mass of *Parmula brownii*, var. had formed.

Loc. Collected by Dr. H. H. Rusby along a small branch of the river Beni in Eastern Bolivia, S. A. (See also *P. brownii.*)

This is the most minute mature sponge that I have ever met with. The masses, even, can hardly be said to be visible to the naked eye

without a suggestive guidance; being about one sixteenth inch in diameter. The first was found, accidentally, on a mount containing another sponge and a very careful and almost despairing search was required before another was discovered. Its generic classification has been somewhat doubtful. But for its entirely abnormal gemmules and the geographical dislocation of the sponges, it might readily have been associated with the highest serial form of *Tubella pennsylvanica*; viz., that in which the rotules are most nearly equal.

For the reasons mentioned it seems best to separate them and place it in the genus *Meyenia*, where it differs noticeably from *M. gregaria*, (found upon the same stem) and from *M. leidyi*; each of which species has a capsular envelope; also from *M. erenaceous* with its unique parenchyma of oblong cells. I have therefore made it a new *conditional* species.

(*b*) *Margins of birotulates rayed.*

(5) **Meyenia fluviatilis, (S. fluviatilis)** Auct. (Pl. V, fig. v, Pl. IX, figs. i to iv.)

Syn. European, See Vejdovsky "Diagnosis." p. 178.
" Asiatic, 1849, *Spongilla meyeni*, Carter.
" American:—

1875	*Meyenia*	(*Spongilla*)	*asperima*,	Dawson.
"	"	"	*stagnalis*,	"
1880	"	"	*astrosperma*,	Potts.
"	"	"	*polymorpha*,	"
1882	"	var.	*acuminata*,	"
1885	"	"	*mexicana*,	"
"	"	"	*angustibirotulata*,	Carter.
"	"	"	*gracilis*,	"

"Massive, lobate. Structure friable, crumbling. Color light yellow-brown. Skeleton-spicule curved, fusiform, gradually sharp-pointed, smooth; often spined and often centrally inflated. Statoblast globular; aperture infundibular; crust thick, composed of granular or microcell substance, charged with birotulates whose umbonate disks are deeply and irregularly denticulated, arranged parallel to each other and perpendicular to the chitinous coat." Carter. (Ann. and Mag. 1881 p. 92.)

My observations upon this species as found abundantly in all parts of North America, and in very variable forms, may be summed up as follows.—

Sponge sessile, massive, rarely throwing out short branches an inch or less in length. Color varying from light yellow or brown to a light green, according to exposure. Surface tuberculated or

irregular; often exhibiting the deep grooves of incomplete, concentrating canals, covered only by the dermal film. Pores and osteoles conspicuous. Texture rather firm; main lines of skeleton spicules and of canals horizontal or nearly parallel to the base of support. Spicules fasciculated.

Gemmules numerous throughout the entire sponge, but in the deeper parts, most abundant; spherical, very variable in size; crust variable in thickness; in some forms nearly or quite wanting, whilst in others it is so thick as to promote the formation of birotulates in two or three concentric zones.

Skeleton spicules curved, fusiform, gradually pointed; varying even in the same specimen from altogether smooth to entirely spined; but nearly always smooth at the extremities; spines, when present, minute, conical. (Pl. IX, figs. i to iv.)

Dermal and interstitial spicules wanting.

Birotulate spicules of the gemmules generally short; rotules flat, irregularly rayed, occasionally microspined, rays straight, deeply cut, nearly to the centre of the rotules; shafts rarely spinous; spines long, tapering. (Pl. IX, figs. i to iv.)

Meas. Skeleton spicules 0·01 by 0·0005 inches. Length of birotulate 0·0005 inches. Diameter of rotules 0·0007 inches.

Hab. In lakes or ponds; preferring standing water.

Loc. Throughout the Eastern and Middle United States generally.

This species under its former name of *Spongilla fluviatilis* has long been known as one of the two fresh water sponges which, until recently, were the only ones generally recognized in Europe. Like *S. lacustris* it is cosmopolitan in habit, and the study of it in this country from a great number of localities, has shown that it, also, is very variable in some of its parts. For instance, its skeleton spicules, as stated above, vary, in specimens from different localities, and to a less extent in those from the same locality, or even in the same specimen, from totally smooth to entirely spined; and the species named on account of the prevalence of one or other of these conditions will have to be given up. Its birotulates also vary greatly in size and proportions, in contour of their shafts and the character of their rays. A few forms may be so definite in their peculiarities, and repeat them in so many localities, as to warrant the use of varietal names; but in this as in other cases it seems best to include all within a definite range in the species under its familiar name.

M. fluviatilis certainly cannot be called a branching sponge, but in some localities, particularly when growing on the lower side of timbers etc. or in a rapid current, I have found it bearing inconsequent processes about an inch in length. In color it inclines to a light brown or yellowish, but in our clear northern lakes, where it grows in large patches exposed upon the upper surface of stones, it is described as of a vivid green.

Meyenia fluviatilis, var. **meyeni.**

Spongilla meyeni, Carter.

Skeleton spicules sparsely microspined, long, cylindrical. Gemmules spherical; chitinous coat and granular crust relatively thick. Birotulates often in two or three partial series; shafts long, cylindrical, generally smooth; rays of the rotules long, conical, deeply divided. An occasional spicule may be found of an intermediate character between the acerates and the birotulates;—that is, it resembles a short acerate with whorls of short spines about one fourth its length from either end.

In his Monograph of 1881 Mr. Carter dropped this one of his original species of Bombay sponges from his classification, merging it with *M. fluviatilis*. For several reasons I incline to retain it as a variety of that species. The size of the birotulates is far greater than the average in the typical species, and their cylindrical shafts and symmetrical forms give them a peculiar beauty. Their occasional arrangement in multiple series is not unique, but the habit was first noticed in this variety.

Meas. Skeleton spicules 0·0108 by 0·0004 inches. Length of average birotulate 0·0013 inches. Diameter of rotule 0·001 inches.

M. fluviatilis, form *astrosperma*, Potts. Syn. Proc. Acad. etc. 1880, p. 357.

The name "star seeded" was applied before the author had the opportunity to compare this with the European type, or even with collections from other parts of this country. It is a beautiful form of the species, with birotulates sufficiently scattered over the surface of the gemmule, to show as stars upon a silver dome (Pl. V. fig. v.) It was found at Lehigh Gap, Pennsylvania; but cannot claim to be even a variety.

M. polymorpha, Syn. was suggested to me by the great numbers of misshapen or incomplete forms surrounding the statoblasts; as in (Pl. IX, fig. iv, e, e, e.) These, as my friend Mr. Carter has shown me, are nearly all abortive birotulates; and when we inquire into their cause we find that they occur almost solely upon gemmules

where the granular crust is wanting. How this absence so affects them, and, in fact, how this class of spicules is developed upon the chitinous coat, must be left to the investigations of later students.

The abnormal habit just mentioned leads us to consider the next variety, in which the modification assumes greater definiteness.

M. fluviatilis var. **acuminata**, Potts. (Pl. IX, fig. ii.) Proc. Acad. Nat. Sci. 1882, p. 70.

"Sponge probably altogether sessile and massive, consisting of an intertexture of stout, fusiform-acerate skeleton spicules, abruptly pointed, coarsely spined, except near the extremities; spines subconical, acute, dermal spicules absent or undiscovered. Gemmules without granular crust; some of them supporting a few, misplaced, irregular or malformed birotulate spicules, the distinguishing feature of which, is the prolongation of the familiar boss or umbo upon the outer surface of each rotule, into a long, acuminate spine, in line with and a continuation of the shaft."

Meas. Skeleton spicules 0·00985 by 0·0005 inches. Length of birotulates 0·00107 inches. Diameter of rotules 0·0007 inches.

To the description above quoted from the "Proceedings etc.," is appended the following in regard to the association of this variety of *M. fluviatilis* with *Spongilla* var. *paupercula* in the Boston Water supply.—

"The exceptional features referred to as marking this collection of sponges, were; first, the fact that all the gemmules, whether belonging to the genus *Spongilla* or *Meyenia*, were *smooth*, that is without a granular or cellular crust; second, the apparent absence of dermal spicules from both, and the abnormal character of those belonging to the gemmules. The occurrence of naked gemmules is not infrequent, but has, so far as known, heretofore been limited to the genus *Spongilla*. The discovery of the same feature in the associated genus *Meyenia*, coupled with the fact that of the small number of birotulates found upon them, a large proportion were imperfect, the rays being more or less aborted, approximating their shape to that of the spined, fusiform acerates of *Spongilla*, gave rise to the suggestion that here, possibly, had been not merely a mechanical mixture, by inter-, or super-position of two dissimilar species, but an organic hybridization, produced by the flowing together of the amœboid particles of which the sponge flesh is composed."

Meyenia fluviatilis, var. **mexicana**, Potts. Am. Nat. Aug. 1885, p. 810.

I find little of novelty in my description of this variety except the following. "Birotulate spicules pertaining to the gemmules, in

length about three times the diameter of the rotules; shafts nearly cylindrical, sometimes more slender near the middle, irregularly spined; spines long, acute. Rotules flat, deeply notched; rays irregular, acute."

"*Meas.* Skeleton spicules 0·0152 by 0·0006 inches. Length of birotulates 0·0021 inches. Diameter of rotules 0.0009 inches."

It is added that "this species (var.) collected by Prof. E. D. Cope in Lake Xochimilco, about eight miles south of the city of Mexico, differs from the familiar *M. fluviatilis* chiefly in the far greater length of the shafts of the birotulate spicules. The specimens examined were probably collected in an immature condition, as suggested by the abundance of sarcode and the scarcity of gemmulæ or statoblasts. The single small group that alone rewarded a careful search through the whole mass of material sufficed, however, to fix its generic and approximately its specific relations. The shapes or proportions of the birotulate spicules would probably indicate its association with the following.

Meyenia fluviatilis, var. **angustibirotulata**, Carter. Ann. and Mag. etc., June 1885, p. 454.

"Sponge coating the stems of aquatic plants to the extent of one sixth of an inch in thickness all around. Consistence elastic, fragile. Color light yellow-brown. Skeletal spicule smooth, curved, fusiform, gradually sharp-pointed, varying in size under 75 by 3–6000 ths. inches in its greatest dimensions.

Statoblast globular, even on the surface, and white in color when fully developed; infundibularly depressed over the hilous opening of the chitinous coat; about $\frac{85}{6000}$ths. inches in diameter; consisting of the usual germinal contents, surrounded by a layer of birotules in juxtaposition, arranged perpendicularly over the chitinous coat, and filled in between with a microcell-structure up to the umbos of the birotulates, which, being naked and allowing the light to pass through them, present a dark point respectively, like minute holes in the midst of the white microcell-substance; birotule consisting of a cylindrical shaft, more or less constricted in the middle, which is sometimes furnished with one or more spines; rotule fringed toward the margin rather than denticulated, so as to present a striated appearance, which does not reach the umbo or centre; total length of birotule about $\frac{6}{6000}$ths. inches." Carter.

Loc. England and America.

Collected by Mr. B. W. Thomas from Calumet River, near Chicago, Illinois; also by Mr. J. G. Waller, "Ditchley's Manor," Essex, England.

Meyenia fluviatilis, var. **gracilis**, Carter. Ann. and Mag. Sept. 1885, p. 180.

"Sponge delicate in structure, which is soft, whitish or colorless in spirit, presenting the aspect of glue or sarcode when dry; growing over the stem of an aquatic plant in a thin layer charged beneath with statoblasts (gemmules). Spicules of two forms, viz:— 1, skeletal, very fine and delicate, acerate, curved, cylindrical, about 34 to 36 by ½–6000th. inch in its greatest dimensions; chiefly confined to the fibre; 2, statoblast spicules, shaft long, cylindrical, often slightly curved, smooth, also very thin and delicate; head small, flat, radiately denticulated, the ends of the rays not recurved; often umbonated by a projecting spine or process; total length about $\frac{7}{6000}$ths. inches; head 1½–6000ths. inches in diameter; shaft about five times longer than the diameter of the head, about ¼–6000th. inch thick; chiefly confined to the statoblast, but also loose and numerous in the tissue generally. Statoblast globular when wet, hemispherical and depressed in the direction of the aperture when dry; when fully formed about 65 to 75–6000ths. inches in diameter. Aperture slightly marginated, *i. e.* slightly raised above the common level, about $\frac{8}{6000}$ths. inches in diameter. Surface of statoblast rough or uneven. In a section through the centre the crust is seen to be a little thicker than the length of the birotules, which, as usual, are arranged perpendicularly to the yellow chitinous coat beneath and parallel to each other, with one head resting on the chitinous coat and the surface of the other free at the circumference; cemented together and held in position by the microcell-structure or "float," which, projecting above the level of the outer heads of the birotules, gives rise to the roughened state of the surface of the statoblast. Chitinous coat and germinal contents the same as in the *Spongillæ* generally. Size of specimen sent to me about ¼ by ¼ inch horizontally." Carter.

Loc. "Ice Factory Lakes, DeLand, Florida, near the St. John's River." Collected by H. Mills.

(6) **Meyenia (Ephydatia) mülleri**, Lieberkühn. See Vejdovsky "Diagnosis." p. 177.

Of the varieties of this species v. *amphizona* and v. *mirabilis* as well as those species which Mr. H. Mills has grouped under the generic name "*Pleiomeyenia*" as *P. calumeticus*, *P. walkeri*, and *P. spinifera*, I can only say that they have been founded upon the presence

of duplicate or triplicate series of birotulates around the gemmulæ; that this feature was observed long ago, in the case of *S. meyeni*, Carter, since merged with *Meyenia fluviatilis* by the author; and that it did not seem to him nor does it appear to me to be specific, though well worthy of notice. It may be questioned whether the peculiarity would not be found in any specimens that had grown where food or silica had been unusually abundant.

(7) **Meyenia (Ephydatia) bohemica**, F. Petr. See "Diagnosis." p. 179.

(8) **Meyenia robusta**, Potts. (Pl. IX, fig. v.)

Sponge massive, encrusting. Skeleton spicules subfusiform, pointed, smooth. Gemmules scarce, birotulates of large size and generally "monstrous" in form; irregularly shaped, shafts abounding in spines as long as the rays of the rotulæ, cylindrical or conical.

A large specimen of this species, if it be not properly a variety of *M. fluviatilis*, was found in the Museum of the Academy of Nat. Sci. of Phila. marked, "presented by Dr. Geo. H. Horn; collected by him from Honey Lake Valley near Susanville, California."

Meas. Skeleton spicules 0·01175 by 0·00055 inches. Length of birotulates 0·00095 inches. Diameter of rotules 0·0008 inches.

(9) **Meyenia millsii**, Potts. (Pl. X, fig. ii.)

Sponge encrusting; texture loose.

Gemmulæ spherical, small, surface smooth.

Skeleton spicules nearly straight, cylindrical, slender, rather abruptly pointed, entirely microspined; spines few, low, conical.

Dermal spicules absent or undetermined. (A few minute forms sometimes slightly curved, cylindrical but inflated near the middle, may be only the initial condition of the birotulates before their disks have been fully developed.)

Birotulates surrounding the gemmules very numerous and symmetrical, their outer rotulæ forming a smooth exterior to the gemmule. Shafts nearly cylindrical, but rapidly widening immediately under the rotules; frequently with a single spine near the middle. Umbonate rotulæ large, flat; margins finely lacinulate, often microspined upon both surfaces.

Meas. Skeleton spicules 0·0107 by 0·0005 inches. Birotulates 0·0012 by 0·00015 inches. Diameter of rotules 0·00075 inches.

Loc. Collected from Sherwood Lake near DeLand, Florida, by Henry Mills, Esq.

Respectfully dedicated to my friend Mr. Mills of Buffalo N. Y. to whose perseverence as a collector we owe this and the following beautiful species; the first new forms from the state of Florida; besides specimens of *S. fragilis*, *M. fluviatilis* and *H. ryderi* at this southernmost point of their range.

(10) **Meyenia subdivisa**, Potts. (Pl. IX, fig. vi.)

Sponge green when growing in the light, massive, encrusting; texture compact; composed of thick lines of fasciculated spicules and having a peculiarly vitreous, glistening appearance when dried. Surface smooth or rising into more or less abrupt rounded prominences, *near* the extremities of which the efferent osteoles are found. Pores numerous, conspicuous.

Gemmules few, spherical, resembling in appearance those of the genus *Heteromeyenia*; granular crust very thick.

Skeleton spicules cylindrical, robust, abruptly pointed, smooth; the smaller ones more or less microspined. In many places at the surface they gather into flocculent or wool-like masses, compactly grouped, without interspaces. (See remarks on *Tubella pennsylvanica.*)

Dermal spicules absent or undiscovered.

Birotulate spicules surrounding the gemmules very numerous; so crowded that some become displaced and, standing out beyond the others, simulate the appearance of the longer class of birotulates in *Heteromeyenia*. As all are of the same general shape however, and nearly of the same size, it is thought best to retain the species in the present genus. These spicules are very robust and the abundance of silicious material is evidenced by the repeated subdivision of every ray and spine. (Pl. IX, fig. vi, e. e. e.) Shafts cylindrical, frequently spined; rotules flat, irregularly circular, notched but slightiy at the margin. Short rays subdivided.

Meas. Skeleton spicules 0·01 by 0·0006 inches. Birotulate spicules 0·0017 by 0·0003 inches. Diameter of rotules 0·0009 inches.

Hab. On submerged timber etc.

Loc. Collected by Mr. H. Mills in St. John's River near Palatka, Florida.

Dr. Bowerbank has remarked (Proc. Zool. Soc. 1863, p. 443, etc.) upon the number and variety of sponge spicules noticed by him in a collection of infusorial earth, made by Prof. Bailey in Florida; and from this fact and the descriptions of other travellers it has long seemed to me an ideally favorable place for the growth of sponges.

As circumstances prevented personal exploration in that direction, repeated efforts have been made to enlist the assistance of intending visitors, in the search for them; and much disappointment was felt when one friend, a most successful collector in other lines of natural history, reported that he could find none, attributing his failure and their apparent absence to the abundance of confervæ covering every probable place of their growth.

Since these failures Mr. Mills has made two visits to Florida; both during the latter part of our winter season, say from February to April; and the experience gained in many Northern waters has helped him to success in these. He has gathered several familiar species of *Spongilla*, *Meyenia*, *Heteromeyenia*, and *Tubella*, beside the two novel forms just described. The first of these, *M. millsii*, approaches *M. fluviatilis*, but differs from any of its varieties in the character of its rotules, which, instead of being deeply cut into rays, are delicately fringed or lacinulated like those of the smaller class of birotulates in *H. ryderii*. (Compare Pl. X, fig. ii, with Pl. XI, fig. v. c. c. c.)

The finest specimen of *M. subdivisa* grew upon the bark of a submerged pine log in the St. John's River, near Palatka, and covered it to the extent of two or more square feet, by an average of one half or three fourths of an inch in thickness. Its peculiarities are perhaps sufficiently stated above, but I remember being much impressed by the vitreous appearance mentioned, as suggesting that of the tropical South American forms of *Tubella*, *Parmula* and *Uruguaya*. A further search at points nearer the Southern extremity of the peninsula may give us some of these.

(11) Meyenia (Spongilla) baileyi, Bk. Proc. Zool Soc. etc. 1863, p. 451.

"Sponge coating; surface smooth? Oscula and pores inconspicuous. Dermal membrane spiculous; spicula fusiform-acerate, entirely spined: spines of the middle cylindrical, truncated, very long and large. Skeleton spicula subfusiform-acerate, rather slender. Interstitial membranes spiculous; spicula same as those of the dermal membrane. Ovaria globular, smooth, abundantly spiculous; spicula arranged in lines radiating from the centre to the circumference of the ovary; birotulate; rotulæ irregularly and deeply cleft at the margins, incurvate; shaft very long, cylindrical, entirely spined; spines conical. Color in the dried state dark green." Bowerbank.

"*Hab.* A stream on Canterbury Road, West Point, New York." (See remarks as to *Heteromeyenia repens*.)

(12) **Meyenia (Spongilla) capewelli,** Bk. Proc. Zool. Soc. etc. 1863, p. 447.

"Sponge massive, sessile; surface uneven, often lobular, smooth. Oscula simple, minute, dispersed. Pores inconspicuous. Dermal membrane pellucid, aspiculous; skeleton spicula acerate, rather short and stout. Ovaria subglobose; spicula birotulate, rather long, disposed in lines radiating from the centre of the ovary; rotulæ flat, margins slightly and irregularly crenulate; shafts slender, incipiently spinous, varying in length from one to one and a half diameter of a rotula. Color dull green, with a tint of yellow." Bowerbank.

Hab. Lake Hindmarsh, Victoria, Australia."

(13) **Meyenia anonyma,** Carter. Ann. and Mag. etc. 1881, p. 95.

"Sponge unknown, statoblast flask shaped; aperture terminal; composed of a membranous coat, striated longitudinally, supporting a reticulation consisting of extremely minute, erect, conical processes with their sharp ends inwards, and presenting in the centre of each interstice, especially towards each fundus, a short, thick, somewhat hour-glass-shaped spicule, whose outer end is more or less denticulated and whose inner one is inserted into the striated coat. Investing membrane of the germinal matter transparent, presenting the usual polygonal reticulation without granules, like compressed cell-structure." Carter.

Loc. River Amazons.

(14) **Meyenia ramsayi,** W. A. Haswell. Proc. Linn. Soc. New South Wales, 1882, p. 209.

"Sponge massive, tubercular, with finger-like projections.

Skeleton-spicules curved, abruptly pointed, smooth.

Birotulate spicules, shafts cylindrical, with one to ten prominent spines; rotulæ deeply dentate; twelve to twenty teeth.

Loc. Bell River at Wellington, Australia." Haswell.

(15) **Meyenia crateriformis,** Potts. Proc. Acad. Nat. Sci. etc. 1882, p. 12. (Pl. V, fig. vi. Pl. X, fig. v.)

'Sponge encrusting, thin; texture very loose, forming no tangible skeleton.

Gemmules small, white, very numerous, visible from the upper or outer side of the sponge. Granular crust relatively extraordinarily thick, embedding slender spicules of great length. The foraminal tubule, standing at the centre of a crater-like depression amongst these, has suggested the specific name. In position the shafts of these long birotulates are rarely parallel, but, leaning to

each side, cross each other in a perplexing and beautiful manner. (Pl. V. fig. vi.)

Skeleton spicules slender, fusiform, gradually pointed, sparsely and minutely microspined.

Dermal spicules somewhat apocryphal. (While smooth, slender, cylindrical forms that seem to be such, prove, in their further development, to have been merely immature birotulates, pertaining to the gemmules, there *are* others, still more slender and acuminate, that *may* be strictly dermal.)

Birotulates of the gemmules very long and slender; shaft cylindrical, whose length is five or six times the diameter of the supported rotules; abundantly spined, more particularly near the ends; spines long, cylindrical, rounded or recurved. Rotules composed of 3 to 6 short, recurved hooks with finely acuminate points. (Pl. X, fig. v, b.b.b.).

Meas. Diameter of gemmules 0·013 inches. Skeleton spicules 0·01 by 0·0004 inches. Length of birotulate spicules 0·0025 inches. Diameter of rotules 0·0004; of shaft 0·00015 inches.

Hab. On fixed or floating timber in shallow water.

Loc. Crowe's Mill, Brandywine Creek; Ivy Mills, Chester Creek; Fairmount Dam, Schuylkill River; and League Island and Lambertville, Delaware River, Pennsylvania.

The tradition that associates the Brandywine Battle Ground with the vision Lord Percy is said to have had of such a scene before leaving England, as the spot where he should meet his death in battle, is so far justified by the fact that it is indeed one of the loveliest scenes in Pennsylvania. These undulating hills, crowned with forest or waving with golden grain; the emerald meadows lining the broad stream on either side; the smaller brooklets gathering in the hollows and gurgling among the rocks, as they wind their way down to the main stream, form a scene of peace and tranquility which it is difficult to fill, in our own imaginations, with conflict and bloodshed or cover with the "thunder clouds of war."

It lay thus peacefully one summer day in 1881, when our wagons drew up near the old fashioned grist and saw mills, then occupied by Mr. Frank Crowe, about one mile above Chadd's Ford, made famous on that Revolutionary occasion. Some of the party went "a-fishing," but of course sponge hunting was the order of the day with the writer. Drawing on high rubber boots, I waded into the stream where the broad mill-race, a creek in itself though but a

small portion of the Brandywine, narrows into the forebay and hurries on to the clattering wheels. At this point a rock-built overflow, like a dam breast, had checked a number of nearly water-logged timbers, and others were aground in the shallow water below. Many of these when turned over disclosed specimens of a filmy gray sponge, branching off here and there along the surface of the wood, yet with a curious want of continuity, as if its particles, in their haste to march forward, had neglected to keep open communication with their base of supplies. All along the lines and dotting the broader portions, small white or yellowish gemmules gleamed through the thin dermis, instead of being buried as in most other sponges in the deeper parts of the tissues.

This was the first discovery of *M. crateriformis*; it was afterward found in somewhat similar situations and with like characteristics in several other Pennsylvanian streams. So far as I remember, none of this species has reached me from abroad, except in one instance, where the situation and circumstances were entirely dissimilar. They will be found described in association with the sketch of *Meyenia plumosa.*

M. crateriformis was far from being the only sponge found on the occasion above described. In the lower corner of each mill, where the water boiled and rushed as it escaped from under the wheels, the stones and timbers bore many specimens of *S. lacustris*, *S. fragilis* and *M. fluviatilis*, The growth of the second of these, upon timbers lining the inner walls of the grist mill, was particularly abundant, nearly white and full of segregated spores.

(16) **Meyenia everetti,** Mills. Proc. Am. Soc. Micros. 1884. (Pl. X, fig. iii, and iv.)

Sponge green, without sessile portion, but consisting altogether of slender meandering filaments, little more than a sixteenth of an inch in diameter; made up of central lines of closely fasciculated skeleton spicules, with short thin lines of the same, diverging at angles of 30 to 50 degrees, and, on the surface, numerous single spicules, as yet unplaced, and forming no proper network. Near their ends the fronds were abruptly reduced, nearly to the diameter of the central band of spicules, and appeared to terminate in a sharp point.

Gemmules few but unusually large, as the crust is thick and the embedded birotulates are longer than in most other species. They are found axially, in a single series, along the fronds; each enclosed in a rather loosely formed capsule or cage of skeleton spicules, the

diameter of which is much greater than that of the included gemmule.

Skeleton spicules slender, cylindrical, gradually or more abruptly pointed, smooth. (Pl. X, fig. iii and iv, a.a.a.)

Dermal spicules, minute *birotulates* with slender, cylindrical shafts, and cap-like rotules, notched at margin into five or six hooks. (Pl, X, as above, c.d.e.)

Birotulates surrounding the gemmules long, but variable in length. Shafts smooth, slender, particularly near the middle; widening and becoming almost club-shaped at the extremities, where the rotules are formed of five or six stout, recurved, acuminate hooks.

Meas. Diameter of gemmules 0·027 inches. Skeleton spicules 0·0082 by 0·0002 inches. Gemmule birotulates 0·0025 by 0·0001 inches. Diameter of rotule 0·0008 inches. Length of minute dermal birotulate 0·00063 inches.

Hab. On submerged grass, weeds etc. in shallow water.

Loc. Gilder Pond, Mt. Everett, Berkshire Co. Mass; collected by F. Wolle and H. S. Kitchel: MacKay's Lake, Pictou Co. Nova Scotia; Collected by A. H. MacKay.

My friends Dr. Francis Wolle and H. S. Kitchel Esq. of Bethlehem, Pennsylvania, in the pursuit of their favorite study of desmids and diatoms visited Mt. Everett near the extreme S.W. corner of Massachussetts, in September 1882. While devoted to their own specialty they yet in the spirit of true naturalists found real pleasure in gathering subjects in other departments of natural history, for the benefit of their absent friends.

In a note transmitting specimens and written immediately after their return, Mr. Kitchel says.—"Gilder Pond is a small pond some 1800 ft. above the sea, on the side of the mountain, fed by springs at the bottom and the drainage from still higher ground; no inlet, and no outlet except a small stream, which drains through the ground at one end." "It is almost entirely surrounded by rocks and the water is very pure and cold." "The sponge was first found upon the ground in shallow water; afterward in great quantities on submerged bushes etc. along the edge of the pond."

A card from Dr. Wolle a few days later gave the elevation as 2400 feet. The rough sketches prepared by both gentlemen to suggest its appearance while growing, indicated a delicate branching sponge, but the specimens sent had been packed between cards and forwarded by letter; in one case, at least, after partial decomposition

in a bottle of water. There was nothing therefore in the fragments themselves to convince me of their external form except the suggestive presence of the broad bands of fasciculate skeleton spicules referred to in the description.

Four years passed before I was able, by my own observations, to verify the impression so vaguely gathered. It was during the last week of September 1886 that I journeyed for the first time, to Gilder Pond, with the primary object of determining the character of this sponge. Primary but not sole, for no one familiar with the beauty of the Berkshire Hills, would quite credit the assertion that even the most enthusiastic naturalist could limit his enjoyment of them to the act of gathering an insignificant sponge from a tarn upon the mountain side.

No, I saw and enjoyed all that the summer tourist enjoys, the sombre forests, the lichen-covered rocks; the mountain summits near at hand, the wide extended view which each gave to its visitors. I also climbed Mt. Everett, "the dome of the Taconics," and sat alone, the center of an unbroken horizon, embracing hundreds of square miles of such varied beauty as may well be the memory of a life time;—but to all this was added the unspeakable charm of a morning spent on the bosom of that little lake, shut in by the silent woods, its flora and its fauna clearly revealed through the bright waters below me. I will not believe that a scientific interest in natural objects can lessen one's enjoyment of the sights and the sounds, the scents and the colors that greet him; the reviving touch of the evening breeze or the exhilarant purity of this mountain air: it adds, instead, a sixth sense, the hope or the joy of discovery.

I found the present species very abundant and others hardly less so; one of them I shall have occasion to describe hereafter. *M. everetti* was widely spread over the bottom of the pond, not on the mud however, the sedimentary alluvium that had gathered here to a great depth; but on the water-weeds and grasses, the submerged verdure, over which it had crawled in slender threads, reaching from leaf to stem and from blade to leaf, as if some giant spider had spun them; but even more like the wavering, inconsequent trail left by a snail or an earth-worm to mark its nightly wanderings. With arm bared and fingers used as a rake, I could gather it plentifully; but its lines were so utterly flaccid that they at once became matted and massed together so as to lose all individuality. Some, now in the bottle at my side, were immersed almost immediately in alcohol, which hardened and preserved it.

This species is a very interesting one, furnishing the first instance among fresh-water sponges, in which the dermal spicule, generally a slender, smooth or more or less spiniferous acerate, is here seen as a well defined and symmetrical *birotulate*. Mr. Carter has kindly brought to my notice a very similar spicule occupying a like position in the marine form *Halichondria birotulata*, Higgins, from the West Indies and S. Australia; but in the case of those from fresh-waters, we have had nothing more definite than the immature or apocryphal forms in *M. crateriformis*. The very peculiar dermal spicules characterizing *M. plumosa* are most suggestive of this, or possibly, of a still more advanced type. (*Spongilla böhmii and S. novæ terræ*, were discovered later.)

The re-discovery of this species among the magnificent collections of sponges made by Mr. MacKay from the water-shed and other lakes abounding in Pictou County, Nova Scotia, gave me great pleasure, as showing the persistence of the type in widely separated districts; and for the confirmation it afforded of my previous observation, as to the general strengthening of spicular features in sponges as their localities approach sea-level.

(17) **Meyenia plumosa**, Carter; (*Spongilla plumosa*, Carter.) Ann. and Mag. Nat. Hist. 1849, p. 81.

"Massive, lobate. Structure feathery, fibrous, friable. Color greenish or light-brown. Skeleton-spicule curved, fusiform, gradually sharp-pointed, smooth. Flesh-spicule stelliform, consisting of a variable number of arms of various lengths radiating from a large, smooth globular body; arms spined throughout; spines longest at the ends, so as to present a capitate appearance, and recurved generally; the whole varying from a simple, spinous linear spicule to the stellate form first mentioned, thus modified by the size and presence of the globular inflation and number of arms developed from the centre of the former; abundant in all parts of the structure, but especially in the neighborhood of the statoblasts. Statoblast ellipsoidal; aperture lateral, infundibular; crust, which is thick and composed of granular microcell-substance, charged with birotulate spicules consisting of a long, straight, sparsely spiniferous shaft whose spines are large, conical and perpendicular, terminated at each end by an umbonate disk of equal size, whose margin is irregularly denticulated, with the processes more or less turned inwards, arranged perpendicularly, with one disk resting on the chiti-

nous coat and the other forming part of the surface of the crust." Carter.

Loc. Bombay.

Meyenia plumosa, var. **palmeri**, Potts. Proc. U. S. Natl. Museum, 1885, p. 587. (Pl. X, fig. vi.)

Sponge (as seen in a dry state) dark brown, massive, attached to and surrounding the dependent branches of small trees whose stems are flooded by the spring freshets. Texture very loose and when dry so brittle that the dermal surface cannot be satisfactorily examined. (The impression conveyed by the interior appearance of this sponge is that it is made up of an infinite number of radiating, confluent branches.)

Gemmulæ large, numerous throughout the deeper portions of the sponge; subspherical or ovoid, surrounded by long birotulates imbedded in a granular crust.

Skèleton spicules straight or slightly curved, mainly cylindrical but gradually sharp-pointed, sparsely microspined. (Pl. X. fig. vi, a.)

Dermal spicules irregularly stellate as in the typical species, but, in the specimens examined, much fewer in number. They vary from simple acerates with one or more long divergent branches to beautiful radiate-spherical bodies whose rays are nearly equal, spined, and capitate by reason of recurved spines at their extremities. (ibid. e, e, e, f.) Another form of spicule, probably also dermal, of which several are seen upon nearly every slide prepared for microscopic examination, is very difficult of description. It may be said to be composed of an irregular series of smooth, curved rays arising from a nearly common centre, and is somewhat suggestive of a hedgehog or Scotch terrier. (ibid, g. g.)

Birotulate spicules pertaining to the gemmulæ, in length about three times the diameter of the supported rotules; shafts cylindrical, plentifully spined; spines long, conical. Outer surface of rotules convex, margins lacinulate; ends of incomplete rays obtuse, recurved. (ibid. b, c, d.)

Sponge masses subspherical, reaching five or six inches in diameter.

This sponge, collected by Dr. Edward Palmer along the banks of the Colorado River, near Lerdo, Sonora, in Northwestern Mexico, about 59 miles S.S.W. from Fort Yuma, California, is a valuable addition to the sponge fauna of this continent and interesting from the fact that the typical species, *M. plumosa* of Carter, has hereto-

fore only been found in his original locality, the rock water-tanks of Bombay, East Indies. That it should skip a whole hemisphere and only be found the second time at its own antipodes is indeed remarkable.

The lower reaches of the Colorado of the West extend for miles through a region described by the collector as "the hottest, driest, and most barren in the United States," whose "vegetation consists of mesquit, cacti, and the screw-bean, *Strombocarpus pubescens.*" Its normal border lands are known as the "first" and "second bottoms," of which the latter are the higher and of course more distant from the channel. By the frequent changes in its bed however, the river cuts through these and, washing away the one and filling up the other, reverses their physical conditions. Upon the "second bottoms" then, said to be only reached to any considerable depth by the annual floods occurring during parts of May and June, and not to continue flooded more than six weeks at a time, the screw-bean abounds. It is described as a small tree of the general appearance of a peach tree, but with more slender, drooping branches. More or less of an alkaline deposit whitens the ground upon which they grow, and the approaching traveler is puzzled to see in strong contrast with it, hundreds or even thousands of dark masses, "like wasp's nests," suspended two or three feet above.

It was this conundrum that confronted Dr. Palmer during his recent visit, and the answer we have in the sponge before us. From the Amazon River in the tropics to the waters of Maine and Nova Scotia in the temperate regions of the north, sponges have long been known to affect the pendent branches of stream-bordering bushes; but it is unlikely that they have ever before been observed in such quantities suspended for nine or ten months of the year over land parched and desolate.

On referring to the earlier descriptions of his discoveries, by H. J. Carter, we find that though he collected this species on two or more occasions, the fragments were always found detached from their place of growth and floating upon the surface in the water-tanks referred to, about one month after the rainy season had commenced. He believed that the vitality of the gemmules was preserved during the dry season, notwithstanding their exposure to the sun and desiccating winds, and that their germination after the water had again reached them was followed by a very rapid growth of new sponge. This would seem to have been the case also

with the present variety as, according to the reports of the collector, the masses could not have been submerged for a greater period than six weeks in any one year. Whether the whole bulk as now seen was attained during a single season, or is the cumulative result of several annual growths of the persistent masses, cannot now be determined. (See description of *Parmula brownii.*)

It is worthy of notice that *M. plumosa* and this variety, v. *palmeri;* differ from all other known fresh-water sponges by the presence in them of a compound or substellate dermal spicule. The spiculæ of the dermis throughout the group are generally minute, spined acerates; in *M. everetti*, Mills, we find them as minute birotulates. In *this* species the two forms seem to be combined; the spines have become central and prolonged, while their capitate extremities suggest the rotules of the last-named species.

Of the six sponge masses from the above locality, sent by the Smithsonian Institution for examination, the smallest was somewhat fusiform in shape and proved to belong to a different species, *Meyenia crateriformis*, Potts, heretofore found along the eastern border of the United States. In it alone, the mass was not darkened by the presence of some pervading vegetable parasite.

(III) Gen. HETEROMEYENIA, Potts.

Proc. Acad. Nat. Sci. Phil., 1881, p. 150. (Pl. VI, fig. i.)

Gen. char. Skeleton spicules and gemmulæ as in *Meyenia;* the latter surrounded by intermingled birotulates of *two classes*, generally differing in form, and whose shafts are of unequal lengths. The proximal disks of all rest upon the chitinous coat; the outer extremities of the less numerous class projecting beyond the others.

This genus now covers at least three well defined species, with several marked varieties, and represents a type or modification of *Meyenia* unknown to Mr. Carter at the time of the preparation of his system. It was founded in 1881 upon the discovery of *H. repens* and *H. argyrosperma* at Lehigh Gap, Pennsylvania; and its necessity was confirmed shortly after by the addition of *H. ryderi*, and its several varieties. It will be seen by the genus definition that it is not intended to embrace mere irregularities in the positions or in the length of gemmule-birotulates, such as may sometimes be found in *M. everetti* or *M. subdivisa*; nor yet to include biserial or triserial arrangements of them. In each of the three principal species described there are essential differences, not merely in the length but in the forms of these birotulates; those of the longer class in

each case being terminated by long, hooked rays, while the rotules of the others are larger, flatter and more delicately divided. (Pl. XI.)

KEY TO THE SPECIES OF THE GENUS HETEROMEYENIA.

1. Rays of long birotulates noticeably incurved like fish-hooks; rotulæ of shorter class mushroom shaped; shafts generally smooth. Dermal spicules present. (Pl. XI, fig. iii.) *H. repens.*
2. Rays of long birotulates few, (1 to 4) long, stout and claw-like; shafts with few spines; rotulæ of smaller class very irregular; shafts abundantly spined. (Pl. XI, fig. i and ii.) *H. argyrosperma.*
3. Rotulæ of long birotulates small; rays hooked; shafts spiniferous: rotulæ of smaller class large, flat; margins lacinulate or delicately rayed; shafts generally smooth. (Pl. XI, fig. iv, v, and vi.) *H. ryderi.*

(1) **Heteromeyenia repens**, Potts. Proc. Acad. Nat. Sci. Phila. 1881, p. 150. (Pl. XI, fig. iii.)

Spongilla repens, Potts. Proc. etc., 1880, p. 357.

Sponge bright green, encrusting, thin. Texture loose and incoherent; the projecting lines of skeleton spicules giving it a peculiarly rough appearance.

Gemmulæ not very abundant, spherical; with granular crust imbedding two classes of birotulate spicules as described.

Skeleton spicules rather slender, subfusiform, sparsely microspined; gradually pointed.

Dermal spicules fusiform, nearly straight, entirely spined; spines cylindrical, rounded; those near the middle perpendicular, much longer than the others.

Gemmule-birotulates of the longer class comparatively few, standing amongst the others; shafts smooth or microspined, nearly cylindrical, often irregularly bent. Rotulæ dome-shaped, the ends of the recurved rays still further incurved like fish-hooks; terminations rounded. (Pl. XI, fig. iii, b.b.)

Birotulates of the shorter class very numerous and symmetrical, about ⅔ the length of the others; shafts generally largest near the middle, or least near the rotules; often with one or more conspicuous spines. Curvature of the rotules like that of a mushroom, or rather flat umbrella; rays not deeply notched; rounded or slightly incurved. (Pl. XI, fig. iii, c.c.c.)

Meas. Skeleton spicules 0·0111 by 0·00045 inches. Dermal spicules 0·0025 by 0·0001 inches. Shaft of long birotulates 0·0029 by 0·00015 inches; diameter of rotule 0·0009 inches. Length of short birotulates 0·00168 inches; diameter of its rotules 0·0007 inches.

Hab. On plants, timber, etc., in shallow water.

Loc. In the pool at Lehigh Gap, Pennsylvania; in Lake Hopatcong, New Jersey, and at other places along the Eastern coast of the United States.

Lehigh Gap, frequently mentioned as a locality in these descriptions, is a rail-road station and quiet watering place, where the Lehigh River forces its way through the Blue Mts. in Carbon County, Pennsylvania. The mountain chain or ridge, with an elevation of about eleven hundred feet above the river, is here abruptly cut through by it, leaving on one side precipitous, jagged edges of bare rock; while on the other it more gradually slopes from the river to the summit.

Nearly at the narrowest point the river is crossed by an old time suspension bridge depending from chains composed of long iron links. On the bank of the river just below, there stands, or until quite recently stood, the ruin of an old mill, that had been burned before the memory of the oldest inhabitant. The mill race, passing under an archway through its walls, was choked by the fallen and blackened timbers, amongst which the water could hardly have been said even to creep, excepting when a freshet in the adjacent river supplied its fauna and flora with a momentary draught of fresh water.

It so chanced that during the early days of my enthusiasm for sponge collecting, curiosity led me to look into this pool, in reality little more than a very wet cellar, with the result of adding a new genus (*Heteromeyenia*) to the system of fresh water sponges, with two species pertaining to the same; also a variety of *Spongilla fragilis*, a form of *Meyenia fluviatilis* and a new species (*T. pennsylvanica*) of the genus *Tubella*, its first discovery in other waters than those of the River Amazons, South America. Numerous specimens of the higher types of minute aquatic life; fine species of *Bryozoa* etc., gave added interest to this field of work.

On October 13th., 1880 the first specimen of *H. repens* was discovered upon the stems and leaves of a *Potamogeton*, by my friend and companion Mr. J. S. Cheyney; and after reaching home I found that I had, myself, collected others from the fallen timbers, without

recognizing their novelty. Its habit was to creep over submerged timbers and sticks, the leaves of water plants, the slender stems of *Nitella* etc., generally, when upon a smooth surface, assuming vermiform lines, one fourth inch or more in width, along which the gemmules were left in scattered groups. Five years later I found it growing in a similar fashion in Lake Hopatcong, New Jersey.

I have been thus particular to give the history of this species because of the doubt that may disturb other minds than my own, whether it may not be identical with *Meyenia* (*Spongilla*) *baileyi*, of Bowerbank; the sponge that Prof. Bailey gathered "from a stream on the Canterbury Road, near West Point, New York." Admitting the resemblance of the spicules that Dr. B. has represented and described, to some of those pertaining to this species, I would call attention to the fact that he has neither described nor represented the more numerous class of birotulate spicules, which, under the supposition that the species were identical, would be a singular omission. If stress be laid upon the resemblance of the dermal spicules of the two forms, I remark that two species of *Carterius* (*C. tubisperma* and *C. latitenta*) have a similar one. The type specimen from which the description by Dr. B. was prepared, was a very small one and I have not had access to it for final comparison. For these reasons and while a doubt remains as to their identity, I incline to hold fast by my descriptive title.

(2) **Heteromeyenia argyrosperma,** Potts. Proc. Acad. Nat. Sci. Phila. 1881, p. 150. (Pl. VI. fig. i.)

Spongilla argyrosperma, Potts. (Proc. Acad. etc., 1880, p. 357.)

Sponge minute, encrusting; color gray; texture loose.

Gemmulæ abundant; relatively large, on account of the unusually thick granular crust, through which the distal ends of the longer class of surrounding birotulates sometimes project, or support portions of it in many conical prominences. (Pl. VI, fig. i.) Foraminal tubule somewhat prolonged; smallest at the extremity. Color silvery white, suggesting the specific name.[1]

Skeleton spicules rather slender, cylindrical or sub-fusiform; abruptly pointed, sparsely spiniferous; spines small, pointed; projecting forward towards the extremities of the spicules. (Pl. XI, fig. i, a.a.)

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[1] If this and some other of the specific names, derived from the Greek, are found not to be in "good form," I can only regret that the discovery of the rule came too late, and that *many alterations* of name may be a worse error.

Dermal spicules apparently wanting.

Gemmule birotulates of the larger class very robust; shafts long, irregularly cylindrical, often bent, occasionally spinous; spines long, pointed, perpendicular or recurved. Rays of the rotulæ one to four, assuming the form of strong, claw-like hooks, recurved and incurved. (Pl. XI, fig. i, b.b.)

Shorter birotulates much smaller, abundantly spined; spines long, conical. Rotules flatter, irregularly hooked. (Pl. XI, fig. i, c.c.c.)

Meas. Skeleton spicules 0·0109 by 0·0004 inches. Long birotulates 0·00543 by 0·0003 inches. Diameter of disks or hooks 0·0012 inches. Length of short birotulates 0·0028 inches. Diameter of disk 0·0007 inches.

Hab. On submerged sticks, stones, etc.

Loc. Lehigh Gap and Holicong, Pennsylvania; New England States, New Jersey, Nova Scotia, etc.

No other sponge as yet found in American waters, can compare with this, in the robustness and positive characters of its birotulate spicules. It was first found at Lehigh Gap and has since been gathered and received from a few other places.

Notwithstanding its strong points, the sponge itself has been known to occur only as a delicate incrustation; or its whilom presence has been recognized by the discovery of the gemmules that had been left after nearly all its skeleton spicules had been washed away.

Heteromeyenia argyrosperma, var. **tenuis,** Potts. (Pl. XI, fig. ii.)

This variety of *H. argyrosperma* differs from the typical species chiefly in the extreme slenderness of all its parts.

Meas. Skeleton spicules 0·0087 by 0·0002 inches. Long birotulates 0·00438 by 0·00015 inches. Diameter of rotules or hooks 0·0006 inches. Length of short birotulate 0·00297 inches. Diameter of its rotules 0·0005 inches.

Loc. Harvey's Lake near Wilkes-Barre, Pennsylvania, and Lake Hopatcong, New Jersey.[1]

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[1] It will be noticed that the slender forms of well known sponges which have, in this work, been uniformily designated as varieties, have been generally collected in waters at high altitudes, *S. lacustris*, v. *montana* at 2500 feet, (Pl. VIII, fig. vi); *S, fragilis*, v. *minuta*, 600 ft.; v. *minutissima* (Pl· VIII, fig. ii.) and v. *irregularis* 1200 feet; *H. argyrosperma*, v *tenuis*, 1200 ft , (Pl. XI, fig. ii); and *Tueblla pennsylvanica*, v. *minima*, at 1800 feet above sea level. On the other hand *H. ryderi*,

Harvey's Lake, Pennsylvania, and Lake Hopatcong in Northern New Jersey, in nearly the same latitude, and with a common altitude of about 1200 feet, may be classed as mountain lakes, lying in the gorges between high hills, wooded or cultivated, and with no outlook in any direction. Of latter years, both have been enlarged and increased in depth by the construction of gates at their outlets. By this means the water has been raised and controlled, in the former, for milling purposes; in the latter, to use it as a feeder to the Morris Canal. In Lake Hopatcong the water thus "backed up" has found its way through cross-gorges into parallel valleys, originally heavily wooded, and the denuded stems and shorter stumps, standing up through the glittering water or resting in the shallows, suggest a prosaic if not a classical appropriateness, in the local name of one of them,–the "River Styx."

In this locality and in the so-called "Cedar Swamp," another deep bay in this nine-mile-long pond, I found my principal sport as a collector. The season (the last of October,) was perhaps rather late for the species represented; but on nearly every floating log or fallen tree top, or loosened stump, could be found when they were turned over, shining patches of white or yellowish gemmules, left in groups upon the smooth surface or partly hidden in little crevices of bark or root. No conspicuous sponge masses, few even of the filmy layers of skeleton spicules; only these scattering and loosely placed aggregations. Great numbers of them were chipped off and dried for more particular examination in the laboratory.

This kind of collecting has been found far more productive of interesting species than where one limits himself to the larger, green sponges. Though not a single massive sponge had been discovered, representatives were collected of three forms of *S. fragilis*, two of *H. argyrosperma*, one of *H. repens*, besides many specimens of *Tubella pennsylvanica*.

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v. *baleni*, (Pl. XI, fig. iv.) came from near Plainfield, New Jersey and from Florida, in both, presumably, at a low level; and one of the most robust forms of *S. lacustris* seen in this country, was gathered from an "Ice Lake" in the Sierra Nevada Mts. at an altitude of 7000 feet. (Pl. VII, fig. i.)

If a reason be sought to account for the prevailing rule in these cases, the plausible suggestion may of course be made, that the water of lakes upon dividing ridges or high table-lands may be deficient in the silicious constituent that would be acquired later, from violent contact with rocks in the bed of mountain streams, etc.; but a much longer series of observations and exact chemical analysis will be needed to make this observation any more than a guess.

(4) **Heteromeyenia longistylis**, Mills. Proc. Am. Soc. of Microscopists 1884 p. 16.

Sponge unknown.

Gemmulæ large, spherical; crust thick.

Skeleton spicules slender, cylindrical to sub-fusiform; gradually pointed, very sparsely microspined.

Dermal spicules fusiform, entirely spined; spines near the middle long, cylindrical; terminations rounded.

Shafts of the larger class of birotulates relatively very long, cylindrical, often bent, generally smooth. Hooks of rotulæ recurved and incurved.

Rotules of the shorter class of birotulates flatter; shafts cylindrical, spinous; spines short, conical.

Meas. Skeleton spicules 0·0103 by 0·00025 inches. Length of dermal spicules 0·0023 inches. Long birotulates 0·0049 by 0·00015 inches. Diameter of disk 0·0009 inches. Length of short birotulate 0·0032 inches. Diameter of its disk 0·0008 inches.

Loc. Lehigh River, Bethlehem, Pa.(?) Collected by Dr. Wolle.

I had been inclined to consider the above merely a variety of *H. argyrosperma*, but the mention of dermal spicules in my description, prepared several years ago from a very minute fragment, has induced me to give it the benefit of the doubt, until the sponge itself can be again collected.

(3) **Heteromeyenia ryderi**, Potts. Proc. Acad. Nat. Sci. Phila. 1882, p. 13. (Pl. XI, fig. iv, v and vi.)

Sponge light green, massive, often hemispherical; texture loose; surface more or less lobed.

Gemmulæ numerous, spherical, relatively smaller than in *H. argyrosperma;* crust thick; foramina inconspicuous, short, tubular.

Skeleton spicules non-fasciculate, fusiform, gradually pointed, entirely spined, except at the extremities; spines broadly conical, often projected forward, towards the terminations of the spicules. (Pl. XI, figs. iv to vi, a,a, etc.)

Dermal spicules wanting.

Long birotulates variable in relative numbers, shafts cylindrical, spined; spines equal in length with the rays of the rotulæ; hooked or curved from the extremities; rotulæ of three to six short, recurved hooks; sometimes umbonate or with a spinous termination. (Ibid. b,b, etc.)

Short birotulates with cylindrical shafts rapidly enlarging under the rotules, bearing one or more perpendicular spines. Diameter

of rotules nearly as great as the length of the shaft; margins lacinulate or crenulate, outer surfaces flat, symmetrical, often microspined; terminations rounded. (Pl. XI, fig. v, c,d, etc.)

Meas. Skeleton spicules 0·0127 by 0·0006 inches. Long birotulates 0·0023 by 0·00025 inches. Diameter of disk 0·0006 inches. Length of short birotulates 0·0012 inches; diameter of its disk 0·0009 inches.

Hab. Timbers, stones, etc., in shallow flowing water.

Loc. Found from Florida to Nova Scotia, and from the Atlantic coast to Iowa, United States.

H. ryderi alone, of this genus, has been found large enough to attract the attention of a casual observer; inclining to form upon plane surfaces, hemispherical or dome-shaped masses several inches in diameter. In these and other cases they are made up of a congeries of lobes or rounded prominences. It was first found in the year 1881, rather plentifully, within a limited space upon the rocky bottom of Indian Run, a very small stream in the neighborhood of Philadelphia, Pennsylvania. The following year it was missing, and I have never since found it in that stream. It has been gathered or received from at least nine American States mostly along the Atlantic coast from Nova Scotia to Florida, but including one remittance from the western state of Iowa. The finest specimen collected was from the timber side of the fore-bay of E. Doughty's mill, Absecum, New Jersey. This was about three inches in diameter and more than two inches in thickness.[1]

H. ryderi has furnished me with my latest and most valuable lesson in group classification. Until quite recently the species stood compact, or with only the single suggested variety, *H. baleni*, where the spicular features were similar, though more slender, and the general form of the sponge had not been particularly observed.

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[1] The circumstance above mentioned as to the failure to find this species at the same place during successive seasons, is a peculiarity of habit only too familiar to sponge collectors. However reliable their recurrence may be in *lakes* or *ponds*, in our smaller *streams* the fact that a species was found at a given locality during one season, furnishes no guarantee for its reappearance there during the next. When *any* sponge is found, the probabilities are rather in favor of its belonging to a *different* species. In the present case, a year or two later, I found, a few yards further down the stream, not *H. ryderi* but *Tubella pennsylvanica*. From my favorite locality for *Carterius latitenta*, a friend, who undertook to bring me a fresh specimen, two or three years after its first discovery, sent me a fine form of *S. lacustris;* and so they go, constantly moving down stream; one species succeeding another as they travel on to the great sea and there—

Last autumn I collected in Gilder Pond, Berkshire Co. Massachusetts, already described, a sponge as different in its general appearance from the typical form of *H. ryderi*, as can well be imagined, but with similar birotulate spicules; and their very dissimilarity in external form led me to think of *H. pictovensis*, in which the gemmule spicules are also like those of *H. ryderi*. It was not at all willingly, but rather in spite of an exceedingly rebellious disinclination, that I came at last to the conclusion that the others had no sufficient claim to specific distinction, as *H. ryderi* typified and included them all.

The strongest member of this species is the variety *H. pictovensis*, next to be described. (Pl. XI, fig. vi.) I have only seen rather minute specimens of it, but believe it to be both massive and compact, and nearly smooth in surface and outline. A form found in the Lehigh River at White Haven, comes next, also with strongly spinous skeleton spiculæ and very robust birotulates. Then comes the typical form from Philadelphia, described above as externally hemispherical, but composed of compacted lobes. In the next v. *walshii*, from Gilder Pond, I imagine the lobes have separated and spread out into the slender, subdividing branches mentioned in the description of that variety. The series probably terminates with the delicate features of v. *baleni* (Pl. XI, fig. iv,) which will most likely be found also branching.

Heteromeyenia ryderi, v. pictovensis, Potts. Proc. Acad. Nat. Sci. Phila. 1885, p, 28. (Pl. XI, fig. vi.)

Sponge light green, even when dry; massive, encrusting. Texture very compact; spicules non-fasciculated, persistent. Surface mostly smooth.

Gemmules as discovered very scarce, spherical; crust thick.

Skeleton spicules cylindrical, short, robust, rounded or abruptly terminated, entirely spined; spines conical at the middle of the spicule, elsewhere generally curving forward toward each extremity. Rounded terminations of spicules covered with short spines, though frequently a single large spine or acute termination is seen at one or both ends. (Pl. XI, fig. vi, a.b.c.)

Dermal spicules absent or undiscovered.

Birotulates of the longer class surrounding the gemmules rather numerous, one third of their own length longer than the others; shafts mostly smooth, conspicuously fusiform, frequently with one

or more long spines near the middle. Rotules consisting of three to six irregularly placed rays, recurved at their extremities. (Ibid. d,d,d.)

Birotulates of the shorter class abundant and compactly arranged around the gemmule; shafts mostly smooth, though sometimes bearing a single spine; irregularly cylindrical but rapidly thickening to support the rotules, which are large, umbonate, nearly flat, and finely lacinulate at their margins; occasionally microspined. (Ibid. e, e, e.)

Meas. Skeleton spicules 0·0075 by 0·00075 inches. Length of long birotulates 0·0021, of short birotulates 0·0012 inches. Diameter of disk of latter 0·0009 inches.

Hab. On submerged wood, etc.

Loc. Collected by A. H. MacKay Esq. of Pictou, Nova Scotia, from several lakes upon the water-shed of that region; and later, from similar situations in Newfoundland.

The close general agreement of the above description, (prepared while the writer was under the conviction that the sponge was a distinct species) with that just given of the typical *H. ryderi*, except as regards the robustness and spinous character of their skeleton spiculæ, (features that we have already seen to be extremely variable) will, I think, help to explain, perhaps to justify my present act in reducing it to the position of a variety of the latter. That there are obvious differences between them is unquestionable; that these differences are specific, I do not *now* believe.

This beautiful sponge was first discovered by Mr. A. H. MacKay during the summer of 1884, when its novelty, as indicated by its unusually robust, entirely spined skeleton spicules, was easily imagined; but the absence of gemmules at that time, precluded the determination of its generic relations, and it continued for a while unnamed. During the last week in December of the same year, a further search was rewarded by the finding of other "specimens upon sticks pulled up through a break made in the ice," and among these a few and but a few gemmules were discovered. These sufficed to place it clearly within the genus *Heteromeyenia*, with the final designation as indicated above.

The skeleton spicules of this variety are more entirely and conspicuously spined than those of any other known North American sponge. In some forms of *Meyenia fluviatilis* they are noticeably spiniferous, though the terminations are generally naked; in *Tubella*

pennsylvanica they are entirely spined. The spicules of *Spongilla igloviformis* are marked with large, prickle-like spines; and amongst material collected at Deep Creek, Virginia, and also from sedimentary deposits in Nova Scotia, still another and more coarsely spined spicule has been collected, whose affiliations have not, as yet, been ascertained. *H.* v. *pictovensis* differs from all these in its *dense* spination and in the relatively great thickness and the rounded ends of its spicules.

Attention is asked for a moment to one fact stated by Mr. MacKay in his letter transmitting the last above specimens. They were gathered in midwinter from under the ice and were as I can testify, of a vivid green color and from *his* description were evidently still growing. The scarcity of gemmules may remind us of a similar condition in the case of *Spongilla aspinosa*, which has also been seen to be evergreen; and of the inference then suggested that they may not exist because they are not *needed*.

The form alluded to as having been found at White Haven has never been named, and does not need varietal designation. Its general spiculation is merely *more* robust than that of *H. ryderi* in a smaller degree than that in which the spicules of v. *baleni* seem *less* so. Intermediately must be placed,

Heteromeyenia ryderi, v. walshii, n. v.

Sponge light green; primarily sessile but soon sending out slender, subdividing branches, palmate, with rounded terminations; giving them a stag-horn-like appearance. Fronds made up of many slender, nearly parallel lines of slightly fasciculated spicules, the net work being completed by crossing lines of single or nearly solitary spicules.

Gemmules infrequent, spherical; crust rather slight.

Skeleton spicules slender, cylindrical, somewhat curved, gradually or more abruptly pointed, sparsely microspined.

Long birotulates with typical rotules of hooked rays; shafts inflated at the middle, with one to five long spines.

Rotules of short birotulates relatively large, flat; margins lacinulate; shafts smooth, thickening under the rotules.

Loc. Gilder Pond, Massachusetts.

During that solitary but most enjoyable morning spent upon Gilder Pond, as already described in my sketch of *M. everetti*, I discovered, early in my explorations, that there were beneath my boat *two* forms of branching sponges. They were not very dissimilar

in size, that is, in the slenderness of their fronds; but in the one case these terminated abruptly in sharp points,—in the other they were rounded as above described, and reminded me of the broadly palmate antlers of a stag. On reaching my microscope their generic difference was quickly discovered.

The name I have attached to this variety is in acknowledgement of the exceptional courtesy shown and the assistance given me by Mr. T. L. Walsh, the owner of the pond and of the surrounding land upon the mountain side.

Heteromeyenia ryderi, v. baleni. (Pl. XI, fig. iv.)

Meas. Skeleton spicules 0·0072 by 0·00015 inches. Long birotulates 0·00185 by 0·000075 inches. Diameter of disk 0·0005 inches. Length of short birotulates 0·0012 inches. Diameter of its disk 0·0006 inches.

Loc. Plainfield, New Jersey; Florida etc.

This variety bears the same relation to its typical species that v. *tenuis* does to *H. argyrosperma.* All classes of spicules are very slender; but with this exception the associated forms resemble those of *H. ryderi.* It is dedicated to my friend Mr. A. D. Balen, who first collected it near Plainfield, New Jersey; but it has since been found in several localities, including the state of Florida where it was collected by Mr. Mills.

It has been remarked in my comments upon *Spongilla novæ terræ* that intermediate forms connecting the genera distinguished by birotulate spiculæ, were frequent. One instance of this is found in the species before us. The genus *Heteromeyenia* is only distinguished from *Meyenia* by the presence of *two* dissimilar classes of birotulates. The numbers of those of the larger class are sometimes so reduced as to be with some difficulty detected; as in a form of *H. ryderi* sent me by Prof. Osborne from Ames, Iowa. In *Meyenia millsii,* from Florida, we have, what is essentially the same sponge, with this class entirely eliminated: as, however, there is left but one class, we can do no other than place that species among the *Meyeniæ.*

Since preparing the above, I have received two contributions of sponges from Mr. Fred. Mather, the intelligent and energetic superintendent of a hatching establishment at Cold Spring Harbor, Long Island, N. Y., under the care of the U. S. Fish Commission. Both of these have proved to be masses of *H. ryderi.* He reports them as growing plentifully throughout the winter, in their tanks and ponds, with the temperature frequently at 32° F. and below. The species

therefore, in this region, as well as in Nova Scotia and New Foundland must be considered as at least occasionally perennial.

(IV.) Gen. TUBELLA, Carter.

Gen. char. Skeleton spiculæ as in the foregoing genera, but sometimes hemispherically rounded at the extremities. Gemmulæ globular or elliptical; apertures lateral or terminal. Granular crust charged with trumpet-shaped inæquibirotulate spicules, of which the larger rotule rests upon the chitinous coat; the size of the outer rotule smaller, but bearing a variable relation to that of the former. The margins of the larger rotules generally entire.

The genus *Tubella* was created by H. J. Carter in 1881 with four species, all from the River Amazon, in South America; one of them was of his own naming; the remaining three having been previously described (as Spongillas), by Dr. Bowerbank. The new genus was needed to separate those sponges having markedly unequal birotulates, from the typical forms of *Meyenia.* The discovery in Pennsylvania during the same year, of a fifth species and afterward of its wide distribution throughout the United States, tends to approve this necessity. Ann. and Mag. 1881, p. 96. (Pl. VI, fig. ii.)

KEY TO THE SPECIES OF THE GENUS TUBELLA.

1. Inæquibirotulate or trumpet-shaped spicules of two forms, upon separate gemmules. The shafts of one form stouter and bearing a larger distal rotule than that of the other. Flesh spicules wanting. *T. paulula.*
2. Shafts of trumpet-shaped spicules long, nearly cylindrical, spiniferous. Flesh spicules entirely spined. *T. spinata.*
3. Sponge structure rigid; terminations of skeleton spicules rounded. Gemmules surrounded by a capsule of spined spicules, much smaller than those of the skeleton. Shaft of trumpet-shaped spicules short, with a ring-like inflation near the larger rotule. *T. reticulata.*
4. Birotulates in two zones, *i. e.* trumpet-shaped next the chitinous coat, surrounded by a zone of short, robust spicules with equal rotules of eight recurved teeth or rays. *T. recurvata.*
5. Skeleton spicules spiniferous. No dermal spicules. Rotules of trumpet-shaped spicules flat or twisted; margins generally entire; shafts smooth. (Pl. VI, fig. ii.) *T. pennsylvanica.*

(1) **Tubella paulula,** Carter. Ann. and Mag. 1881, p. 96.

Spongilla paulula, Bowerbank. Proc. Zool. Soc. etc., 1863, p. 453.

Sponge "thin, encrusting. Surface even. Structure fragile, crumbling. Color now brown. Skeleton spicule curved, fusiform, abruptly sharp-pointed, spiniferous or smooth. Statoblast globular; aperture sunken, infundibular; crust composed of granular microcell structure, charged with two kinds of inæquibirotulates, one form of which is much stouter than the other, and consists of a straight shaft passing by trumpet-like expansion into the large disk, which often has radiating lines, and abruptly terminating in the other, which is only one fourth the diameter of the former; the other form similarly constucted, but more delicate, with the shaft inflated towards the large disk, and the smaller one much less in proportion than in the larger form; the forms not mixed but confined to their statoblasts respectively; arranged perpendicularly, with the large disk resting on the chitinous coat, and the smaller one forming part of the surface of the statoblast." Carter.

Loc. River Amazon.

(2) **Tubella spinata,** Carter. Ann. and Mag. 1881, p. 96.

Sponge "thin, coating, spreading. Structure fragile, crumbling. Color light brown. Skeleton spicule curved, fusiform, gradually sharp-pointed, smooth or spiniferous. Flesh spicule minute, curved, usiform, thin, gradually sharp-pointed, covered with perpendicular spines, which are longest about the centre. Statoblast elliptical, flask-shaped; aperture terminal; crust thick, composed of granular microcell-substance charged with inæquibirotulate spicules consisting of a straight shaft inflated near the small end, and passing by a trumpet-like expansion into the large disk. Sparsely spined; disk circular, smooth, with an even margin, small end consisting of a circular convex head, regularly denticulated on the margin with eight or more conical processes, which are slightly inclined towards the shaft; arranged perpendicularly, so that the disk rests on the chitinous coat and the head forms part of the surface of the statoblast." Carter.

Loc. River Amazon.

(3) **Tubella reticulata,** Carter. Ann. and Mag. 1881, p. 97.

Spongilla reticulata, Bowerbank. Proc. Zool. Soc. etc. 1863, p. 455.

Sponge "elliptical, or fusiform when growing round the immersed small branches of trees. Structure extremely rigid, reticulate, terminating in thorn-like processes on the surface. Color light sea-green when growing in clear water. Skeleton spicules curved or

bent, cylindrical or subfusiform, rounded at the ends, absolutely smooth or sparsely spiniferous, becoming more so towards the statoblasts where they are not more than half the size, thickly spined, and in this shape form a distinct capsular layer around each of those organs. Statoblast elliptical, ovoid; aperture terminal; crust composed of granular microcell-substance, charged with inæquibirotulate spicules consisting of a straight shaft passing by trumpet-like expansion into the large disk, with two or more spines about the centre, and furnished with a ring-like inflation towards the disk; disk circular, smooth, with even margin, which is somewhat recurved, small end consisting of a circular umbonate head, regularly denticulated on the margin, with 6–8 conical processes, which are slightly inclined inwards or towards the shaft; arranged perpendicularly, so that the disk rests on the chitinous coat, and the head or small end forms part of the surface of the statoblast." Carter.

Loc. River Amazon.

(4) **Tubella recurvata**, Carter. Ann. and Mag. 1881, p. 98.

Spongilla recurvata, Bowerbank. Proc. Zool. Soc. etc. 1863, p. 456.

Sponge "sessile, coating. Surface even. Structure fragile, crumbling. Color brownish. Skeleton spicules curved, fusiform, abruptly sharp-pointed, smooth or spiniferous. Statoblast globular; aperture infundibular; crust thick, composed of granular microcell-substance charged with inæquibirotulate spicules, consisting of a delicate, straight, smooth shaft passing by trumpet-like expansion into the large disk, which is circular, smooth, saucer-shaped, inverted, with even margin, curved towards the shaft, and abruptly terminating in the other, which is only one eighth of the diameter of the disk, arranged perpendicularly with the large disk resting on the chitinous coat, and the small one somewhat within the surface of the crust; surrounded by a capsule of short thick spicules, consisting of a straight, smooth shaft, slightly inflated in the centre, and terminated at each end by an equal-sized head, which is prominently umbonate, with circular margin regularly divided into eight conical teeth slightly incurved, arranged perpendicularly around the statoblast, with one end free and the other adherent to the surface of the crust." Carter.

Loc. River Amazon; also Beni River, East Bolivia.

(5) **Tubella pennsylvanica**, Potts. Proc. Acad. Nat. Sci. Phila. 1882, p. 14. (Pl. VI, fig. ii, Pl. XII, figs. i, ii, iii.)

Sponge gray; or, when growing in the light, green; minute, incrusting; surface of mature specimens often found covered with parallel skeleton spicules, not yet arranged to form cell-like interspaces.

Gemmules very numerous, small; granular crust thin or thick; sometimes covering to a considerable depth, the outer extremities of the rotules, which in other cases project beyond it. (Pl. VI. fig. ii.)

Skeleton spicules extremely variable as to length and curvature; sub-fusiform, acuminate or rounded; entirely spined; spines large, conical; terminations mostly rounded. (Pl. XII, fig. i, ii and iii, a.a.a.)

Dermal spicules wanting.

Birotulate spicules surrounding the gemmules numerous, consisting of a large rotule next the chitinous coat; whilst the distal rotule varies in diameter from that of the connecting shaft to near equality with the other. Margin of large rotule generally entire; surface flat and table-like or irregularly exflected; smaller rotule obscurely angular or occasionally notched. Shafts widening toward the larger rotule, variable in length and thickness; always smooth. (ibid b. c. d. etc.)

Meas. Skeleton spicules 0·0066 by 0·0003 inches. Inæquibirotulates 0·00035 by 0·0001 inches. Diameter of large rotule 0.0007 inches; do, of smaller rotule 0·00015 inches.

Hab. On stones and timbers in shallow water.

Loc. Lehigh River and tributaries; also generally throughout the Eastern United States.

The first specimens of *T. pennsylvanica* were found in November 1881, among a miscellaneous collection of sponges from Lehigh Gap, where they had grown, at an altitude of about 600 ft. above sea level. They were minute, barely one fourth inch in diameter; but were welcomed with enthusiasm as the first representatives of the genus that had been discovered in North America or, in fact, anywhere except in the equatorial "giant of rivers." The year following, the species was found growing at White Haven, on the Lehigh River, Pennsylvania, (1000 ft. above the sea); in Lake Hopatcong, New Jersey, (alt. 1200 ft.); and was received from friends in several other parts of the country. My records show its receipt from at least eighteen different

localities within eleven separate states, including the last arrival from Newfoundland. This specimen was peculiar, in so far as the larger rotules deviate from the ordinary rule of entire margins and are found divided into irregular rays or rounded segments. The smaller rotules are clearly rayed, and very irregular in size.

Generally speaking, the specimens gathered were filmy, indicating but a single years growth. At White Haven however, the fragments brought up by my "scraper net" from piling standing in deep water above the dam were, in some cases, a quarter inch or more in thickness; suggesting a serial growth somewhat like that of *Meyenia leidyi.*

The first records of this discovery describe the outer rotules as one fifth the diameter of the inner but varying in a few instances from this proportion to near equality. It required the experience of several years to convince me that, as, in specimens from different localities the prevailing proportions of the rotules differed in like manner, their relative sizes were no guides as to species. As a result of this teaching some names, given to supposed new species, must be ignored; including *T. fanshawei,* intended to honor a gentleman to whose courtesy I am indebted for the opportunity of making many of these explorations; and *T. intermedia,* supposed at one time to be a connecting link, but now known to be the species itself, in one of its multiform conditions.

Far up among the Pennsylvania mountains, fully 1800 feet above the sea, is Bear Lake, one of the sources of the Lehigh River. During a hurried hour or less spent upon it, one autumn day in 1883, we found, as its most characteristic feature, the rocks and rounded boulders in shallow water covered with a thin, light green sponge containing some gemmules. Repeated examinations, made after reaching home, showed it to be a *Tubella* of very delicate and fragile character as to its spicules, and exhibiting some peculiarities that I am not as yet prepared to describe. I have marked it

Tubella pennsylvanica, v. minima, Potts.

Sponge light green, encrusting, thin; texture loose and incoherent, sarcode having a granular appearance not fully understood.

Gemmules few; chitinous coat and granular crust both thin; the latter embedding a relatively very small number of inæquibirotulates.

Skeleton spicules slender, acuminate or somewhat rounded, entirely spined; spines perpendicular, cylindrical; terminations rounded.

Trumpet-shaped spicules with very slender, smooth, cylindrical, shafts, (in prepared specimens very generally broken); proximal rotules, large, flat or contorted; margins entire or more or less rayed; distal rotules hardly larger than the diameter of the shaft, too minute to detect any subdivisions.

After examining some slides of this variety I incidently turned to others of a form collected as an incrustation from some large water pipes, that had conveyed water from the Schuylkill River. The contrast was startling. The skeleton spicules here were short, robust and generally rounded; the birotulates also were very short, say one half the length of those last described; shafts thick and widening into each rotule. Rotulæ nearly equal in size, margins entire and both of them upturned, saucer-like; very closely resembling those of *M. leidyi.*

This was the major term of the series, and was reached after passing those from the 1800, the 1200, 1000 and 600 ft. altitudes; pausing first at 40 or 50 ft. above tide water, near Bristol, Pennsylvania, where, upon a mass of furnace slag, was found *T. fanshawei*, whose rotules bore the relation to each other of 5 to 6 or 6 to 7; then, in Indian Run, and still later, in tide water in the Schuylkill River below the dam, still greater robustness was reached and the rotulæ, found as above, were as nearly equal as those of *M. leidyi.*

The series was now complete from the last described form, back to that in which the outer rotule, and even the shaft itself, had been nearly eliminated; while the general features of the sponge, excepting as to robustness, remained the same. The changes, it will be observed, followed closely the lines of increasing altitude; their *cause* must be left for later determination.

The fact mentioned in the early part of my technical description, that specimens of this species are often seen, having their dermal surfaces covered with parallel-lying skeleton spicules, is well worthy of notice. A portion at least, of the skeleton spicules in all sponges seem to have their origin in this dermal film. If, under a high magnifying power, we watch the surface of a sponge that has germinated and is growing in a stage tank or other convenient receptacle, we will see these spicules carried about in the amœboid wanderings of the dermal cells, the end of each multiplying the motion and swaying like the gnomon of a time piece. Under these conditions they are probably prepared, and as the result of these motions they are placed to form the connecting links between the main lines of

fasciculated spicules, that are themselves formed in the deeper parts of the sponge. In *T. pennsylvanica*, the spicules are short and slightly, if at all, fasciculated; and, as the crossing lines are more numerous, they require a greater proportion of these forms of *dermal* origin.

(V.) Gen. **PARMULA**, Carter. Ann. and Mag. 1881. p. 98.

Gen. char. Skeleton spicules nearly as in *Tubella*; generally robust, their ends rounded or abruptly terminated. Dermal spicules sometimes present. Gemmules surrounded by a granular or cellular crust of considerable thickness, charged with or embedding an armature of shield-shaped (parmuliform) spicules.

In the species of this genus, all from the River Amazon, South America, or from some of its tributaries, a further modification of the birotulate form of gemmule spicules may be observed. The outer rotule, that, in the last previous genus had become much inferior to the other, has now disappeared, as well as the larger portion of the shaft, leaving only the proximal rotule with an acuminate umbo, as a "scutulate" or "parmuliform" spicule.

Our first knowledge of the sponges pertaining to this genus, as well as of three of the Tubellas, already described, is derived from specimens collected by Mr. H. W. Bates during his sojourn upon the Amazon and its branches, from the year 1848 to 1859. His specimens appear to have been generally gathered in the neighborhood of Villa Nova, probably in a side channel of the main river; ("Dark Ygapos in virgin forest, margins of Amazons, Villa Nova.") On his return to England they were sent to Dr. Bowerbank, whose descriptions of them form the most interesting and valuable portions of his monograph.

In the far too meagre narrative that Mr. Bates has given us of his journeyings, ("The Naturalist on the River Amazons," London, John Murray, 1873.) we are informed that the changes of level in this portion of the river between the wet and dry seasons amount to 25 or even 35 feet; that the floods last from three to four months; and when the water retires "the trunks and lower branches of the trees are coated with dried slime, and disfigured by rounded masses of freshwater sponges, whose long horny spiculæ and dingy colors give them the appearance of hedge hogs."

It is rather remarkable that later travellers in this district do not seem to have had their curiosity excited by the singular appearance of these encrusting or suspended masses, so far as to induce

them to collect specimens and bring them to the knowledge of specialists in this branch of science. Few if any, at least, are reported to have been seen or described, until now that a single specimen has fallen into my hands. It was collected during a transcontinental journey from the west coast of South America, through Bolivia and down the Beni, Madeira and Amazon Rivers, undertaken by Dr. H. H. Rusby, travelling in the interest of the enterprising drug firm of Parke, Davis & Co. of New York.

I failed to communicate with Dr. Rusby, as I had greatly desired, before he left the western side of the continent, to request his particular attention to these sponges; and the specimen referred to was one that only incidentally attracted his notice as he floated down the rivers. It was seen not in the water however, but hanging high and dry above it. When I had confirmed his supposition that it was a fresh water sponge, a species of *Parmula*, he wrote,—"It exists abundantly along the River Ibon a small branch of the Beni. When the river overflows, the sponge is deposited in the bushes. It is exactly spherical and of a size varying from that of a walnut to one foot in diameter. The spicules are poisonous when penetrating the flesh, producing a painful swelling that lasts for several days. It is said at times to produce lockjaw.[1] The overflow is annual and lasts only a few weeks. The sponge appears to vary in other localities in which I saw it. Beside this there are other quite different species that are deposited at the same time. One is a very dirty thing, like a mass of mud, or of mud mixed with ashes; of most irregular form, looking like the mud nests made by some species of ants and bees."

The principal specimen received from Dr. Rusby and probably the only species that he was aware that he collected, nearly resembles *Parmula brownii* (*S. brownii*, Bk.) and will be presently described

[1] I can say nothing confirmatory of the supposed poisonous character of these spicules, except what is probably already well known,—that when handling dried fresh water sponges of any kind, if the forehead, neck, wrists etc. are accidentally touched by the fingers, to which spicules may have adhered, the latter penetrate the skin and produce very perceptible and irritating welts which remain for several hours. I received recently from Mr. Henry L. Osborn of Lafayette, Indiana, a sample of fine dirt that was complained of by laborers who cultivated a certain field, as producing a greatly irritated condition of the skin in dry weather, when, as dust, it settled upon them. It appeared that a portion of this field had been an old "pond hole," since drained; and I found the dust to abound in the spicules of sponges that had once lived there.

as a variety of that species. Upon the slender stem that supports it however, on the two leaves pertaining to that stem and even parasitical amongst the spicules of the primary sponge, I discovered several other kinds; viz.—on the stem, little groups of *Meyenia gregaria* almost exactly as Dr. Bowerbank has described them;—on the leaves, *Spongilla navicella*, Carter, whose enigmatical character has been alluded to in the remarks on that species; also a curiously minute new species now described under the name of *Meyenia minuta;* and upon or within the sponge itself, a few gemmules of *Tubella recurvata* and many of a new species of *Parmula*, that will be presently noticed: six species belonging to four genera; with distinct but insufficient indications of one or two others. With a productiveness and withal a variety so great as this, it may not be cause of wonderment that the writer should feel that were the opportunity afforded thoroughly to examine a single log, that had floated for a year in one of the side channels of the Amazon, the history and classification of fresh-water sponges in America might have to be in large measure rewritten.

KEY TO THE SPECIES OF THE GENUS PARMULA.

1. Sponge rigid, coarsely reticulated. Gemmule surrounded by a tuberculated parenchyma, charged with parmuliform spicules, both upon the chitinous coat and on the outer surface of the tubercules, in which they are associated with a minute spined acerate. *P. batesii.*
2. Sponge rigid, coarsely reticulated. Crust of gemmules granular, penetrating the compact spicular capsule by many slender processes. No outer series of parmuliform spicules. *P. brownii.*
3. Sponge minute; skeleton spicules not fasciculated. Crust of large granuliferous cells forming irregular rounded lobes whose size and shape are determined by the interspaces of the spicules of a much less compact capsule. No spined acerates. Parmuliform spicules forming a complete armature upon the chitinous coat. *P. rusbyi.*

The descriptions of the older species are copied from H. J. Carter, preferred to those of Dr. Bowerbank as showing the results of a later study of the specimens and one made in the light of the revised classification; yet in the course of my study of the same species I have been delighted with the minute accuracy of Dr. Bowerbank's observations, particularly those included in his general remarks.

(1) **Parmula batesii,** Carter. Ann. and Mag, 1881, p. 99.

Spongilla batesii, Bowerbank. Proc. Zool. Soc. 1863, p. 459.

Sponge "more or less globular when growing round the small immersed branches of trees one inch or more in thickness. Structure coarsely reticulate, extremely hard and rigid, rising into thorn-like processes on the surface. Color light sea-green. Skeleton spicule curved, fusiform, abruptly sharp-pointed, smooth, forming, when bundled together with the hard transparent sarcode, the rigid structure above mentioned, charged throughout with statoblasts. Statoblast large, globular, more or less uniformly tuberculated. Aperture infundibular. Crust very thick, composed of granular microcell-structure of a white color, which, growing out through the interstices of the reticular arrangement of skeleton-spicules, reduced in size, which form a capsular covering to the statoblast, gives it the tuberculated character mentioned. Charged with and surrounded by minute, thin, curved, fusiform, gradually sharp-pointed, spinous acerates, irregularly dispersed throughout its substance, limited, both inside and outside, by a layer of parmuliform spicules, the former in contact with the chitinous coat, and the latter on the free surface of the crust, giving it a light brown color. Parmuliform spicule circular, flat, infundibuliform, terminating in a point, like a little round shield turned up at the margin, which is even, arranged both internally and externally in juxtaposition, more or less overlapping each other, with the funnel-shaped process outwards in both instances, so that the surface of the crust is covered with little points." Carter.

Loc. River Amazon.

(2) **Parmula brownii,** Carter. Ann. and Mag. 1881, p. 99,

Spongilla brownii, Bowerbank. Proc. Zool. Soc. 183, p. 457.

Sponge "globular four or more inches in diameter, appended to a small twig rather than embracing it. Structure and color the same as in the foregoing species. Skeleton-spicules the same but diminished to half their size round the statoblasts, to which they afford a distinct capsule. Statoblast globular; aperture slightly infundibular; crust thin, composed of microscopically minute, spherical cells, irregularly agglomerated together, so as to produce small lacinuliform processes, which project into the interspaces between the capsular spicules; unaccompanied by the spinous spicule, which is present in the foregoing species, and without a continuous layer of the parmuliform spicule over the surface, but presenting one in contact

with the chitinous coat, where it is overlain by an extremely thin development of the microcellular crust, from which the lacinuliform processes above mentioned are projected." Carter.

Loc. British Guiana.

Parmula brownii, var. tuberculata, n. var.

Sponge as seen in a dried state, dark brown, massive, spherical; enveloping the small twig upon which it had grown. Mass extremely rigid, spinous at the superfices; reticulations many times larger than those of any known North American sponge. (The sarcode and dermis have now almost entirely disappeared.)

Gemmules numerous; granular crust rather thin, surrounded by a dense capsule of spicules, the interstices of which it penetrates by numerous fibre-like extensions, which, when seen in small white rounded prominences outside the capsule, give it a peculiar mottled appearance. The gemmules are firmly attached by their capsular spicules to the radiating and connecting lines of skeleton spicules *near* their outer extremities, and form a continuous zone just within the mass.

Skeleton spicules smooth, robust, nearly cylindrical, but slightly thicker at the middle; terminations abruptly pointed. Those of the capsule are similar, but about one half the length of the former and more curved. Many of them are covered with large and beautifully rounded tubercles which are the marked features of this variety.

Dermal spicules very minute, slender, spined acerates; spines at the middle long, perpendicular, rounded.

Gemmule spicules parmuliform or shield shaped; consisting of a subcircular proximal rotule with entire margin, then rapidly tapering into a central boss or spine whose length may be equal to one third or one half the diameter of the rotule. These are embedded under the crust resting upon the chitinous coat.

Hab. Upon trunks and branches of submerged trees.

Loc. Beni River, East Bolivia, S. A. Collected by Dr. H. H. Rusby.

The specimen of this variety of *P. brownii*, received from Dr. Rusby is about five inches in diameter, very rigid to the touch, but with meshes relatively very large, so that it was possible to see through the mass nearly at the centre. Its attachment to the twig around which it grew, is, at present, but slight, the twig having shrunken away from the primary supporting membrane. The radiating lines of skeleton spicules, slender at first, have gradually

increased with the growth of the sponge, until, near their ends, their thickness may be that of 30 to 50 skeleton spicules *en fascicle.* In its living condition, of course, these lines of spicules were clothed with sarcode, and the outer surface, without doubt, was surrounded by a dermis of greater or less density, giving the sponge more the appearance of a solid mass than it has at present. The dermal spicules above described were found in some small patches of adherent brown substance, where they were associated with the proper skeleton and capsular spicules of this species and are therefore assumed to belong to it though not found *in situ.*

The gemmules are here a very interesting feature. Throughout the outer half inch of the mass, they are seen attached to every spicular thread, less like beads than grapes, and appear to have been formed at the close of the season of growth, or just before the retirement of the waters, left the sponge hanging in mid-air. It is of course important to learn, so far as may be possible from the examination of this specimen, whether the whole of the mass was formed during a single period of submergence. If not, I argue that another zone should be found within the first, formed at the termination of a previous season, the germination and colonial growth of whose gemmules would give rise to the "second story" of this structure. This appears to be the case. A spherical space of, say, one and a half inches diameter, at the centre of the mass, is charged with gemmules, while between this and the outer zone of gemmules, a space more than an inch in breadth is almost or entirely clear of them. It is supposable, therefore, that this specimen represents a growth of two years, at least of two seasons of submergence, and that the life of the sponge, whether it be in the condition of ova or of resting spores merely, has been preserved in the gemmules in despite of, say, eight or ten months of absolute desiccation.[1]

(3) **Parmula rusbyi**, n. sp.

Sponge minute, parasitic upon *P. brownii*, v. *tuberculata*; Spicules non-fasciculate. Mass, as seen, with no definite outline.

[1]After writing the above, it occurred to me to attempt the germination of some of the gemmules under consideration, and in one instance, within two days, and in another, in six hours after placing a few in water, an extrusion of germinal matter was observed. In neither case has this yet resulted in a recognizable embryonic sponge, but they sufficiently evidence continued vitality.

Gemmules numerous, without attachment, resting within open-meshed capsules, through which the crust expands itself in many large and irregularly rounded lobes, composed of large parenchymal cells filled with granular matter,[1] beneath which, in a single layer, the parmuliform spicules rest in a normal fashion upon the chitinous coat.

Skeleton spicules almost indistinguishable from those of the supporting species; their principal feature being, that they are loosely aggregated and never occur in bundles of fasciculated lines.

No dermal spicules seen.

Parmuliform gemmule spicules rest upon the chitinous coat, and from above them the parenchymal crust easily separates.

Hab. Only known within the meshes of *P. brownii.*

Loc. Beni River, etc. S. A.

The characteristic gemmules of this species (?) were first noticed among the debris of the above named variety. After an earnest effort to determine their origin and associations, they were at last traced to certain minute flocculent masses of indefinite shapes resting among the spicular lines of that sponge. The gemmules certainly differ in type from those of either of the before described species, and but one other solution occurs to me, besides that which I have adopted; viz. making it a new species; and this is, the possibility, barely a possibility, that they pertain to the principal sponge, as errant or floating gemmules, for the distribution of the species; as the more common and normal forms of *P. brownii* are so heavily weighted with capsular and skeleton spicules that when detached, they sink promptly to the depths of the water.

Pending the solution of this problem, I name it as a provisional species after Dr. Rusby, from whom science has received much and hopes for more.

(VI) Gen. **CARTERIUS**, Potts.

Carterella, Potts & Mills; Proc. Acad. Nat. Sci. 1881, p. 150.

Gen. Char. Skeleton spicules as in *Spongilla* or *Meyenia.* Gemmulæ globular, the chitinous coat around the foraminal aperture

[1] A re examination of several mounted specimens of *P. rusbyi*, made with a view to affirm or disprove certain suggestions of my friend Carter, has convinced me that the *granular matter*, above spoken of in this and probably also in other cases, differs from that condition of the crust that has been called *cellular* in no other respect than in the *size* of the cells. The large parenchymal cells in this case, therefore, contain within them or are subdivided into, immense numbers of the smaller kind. It should be said that Mr. Carter prefers to consider this a mere variety of *P. brownii.*

expanded and prolonged into a tube of variable length in the different species, whose termination is either funnel-shaped, disk-like with fibrous margins, or divided into one or several cirrous appendages sometimes of considerable relative length, curling or twisting about each other or surrounding objects. Birotulate spicules akin to those of *Meyenia* or *Hetromeyenia*. (Pl. VI, figs. iii, iv, v and vi.)

The name *Carterella* was first applied to this genus in June 1881, at the suggestion of Mr. (now Prof.) Jno. A. Ryder, in honor of my friend H. J. Carter, Esq. F. R. S. etc. whose scientific life, more than that of any other man had been devoted to the study of the marine and fresh water sponges. During the previous summer two species possessing the features indicated had been discovered by Mr. Mills of Buffalo and myself, and briefly described as of the genus *Spongilla*, which had not then been divided. The approval of Mr. Mills was courteously given to the use of the name *Carterella*, which, a few years later was necessarily changed to *Carterius*, on the discovery that the former term had been preoccupied by Zittel in the same association, to designate one of his fossil types. At that time and for several years after, the occurrence of cirrous appendages was altogether unknown among European sponges; but the past few years, which have been so fruitful of American species in foreign parts, have developed one of this type in Russia, and later, in Bohemia, called by its discoverer, Dr. W. Dybowski, *Dosilia stepanowii*.

The tendrils of the three recognized American species, *C. tubisperma*, *C. latitenta* and *C. tenosperma*, differ obviously in length and character, and with the Russian species probably present as many types of these organic features, as it will be profitable to designate by specific names. Several intermediate forms have, however, been noticed by Mr. Mills and B. W. Thomas Esq., of Chicago, varying as to the length of the foraminal tubules and the character of the supported tendrils; the most noticeable case, being the substitution of a flaring funnel-shaped termination of the tubule, for the latter organs.

KEY TO THE SPECIES OF THE GENUS CARTERIUS.

1. Foraminal tubule terminating in [illegible] quadra[illegible] lar [illegible] at whose angles the chitin divides [illegible] pr[illegible] [illegible] gth. (Pl. VI, fig. iv.) *C.* (*D*[illegible]) [illegible]
2. Foraminal tubule very [illegible] ir lar, or wavering. (Pl. V[illegible], [illegible])

3. Foraminal tubule shorter; tendrils one or two, enveloping the tubule. (Pl. VI, fig. v.) *C. latitenta.*
4. Foraminal tubule still shorter; tendrils three to five, very long and slender. (Pl. VI, fig. vi.) *C. tenosperma.*

(1) **Carterius stepanowii**, Petr. (Pl. VI, fig. iv.)

Dosilia stepanowii, Dybowski. 1884. See Vejdovsky, "Diagnosis" etc., p. 179.

In reference to this species, described as above by Prof. Vejdovsky, I am kindly permitted to make use of the following note by H. J. Carter, F. R. S. etc. in Ann. and Mag. Nat. Hist. 1887, p. 212.

"This fresh-water sponge, which in 1884 was named "*Dosilia* (?) *stepanowii* by Dr. W. Dybowski, from a specimen found near Charkow, in southern Russia (Annals, 1884, Vol. XIV. p. 60), was also found in 1885 by Prof. Fr. Petr, of the University of Prague, in the neighborhood of Deutschbrod, in Bohemia, about 60 miles South East of that city; and his description of it, which is beautifully illustrated, was published in the Czech language at Prague, in 1886. It appears to be the same as that discovered by Mr. H. Mills, of Buffalo, New York, in the Niagara River, in 1880, viz: *Carterius tubisperma* (Proc. Acad. Nat. Sci. Philadelphia, 14th. June, 1881, p. 150).

"Thus this remarkable genus of *Spongilla*, first brought to notice by Mr. Ed. Potts, of Philadelphia, in a specimen found in a small stream in the late Centennial grounds, Fairmount Park, Philadelphia (*ib.* about August, 1880,) which he then named *S. tentasperma*, and subsequently *S. tenosperma* (*ib.* p. 357), ending with *Carterius tenosperma*, its present name, has now been found in Southern Russia and mid-Europe, as above stated.

"In the same communication also Prof. Petr has described and illustrated, under the provisional name of *Ephydatia bohemica*, another fresh-water sponge, found at Kavasetice, in the same district, wherein the statoblast presents an incipient condition of the curious development characterizing *Carterius*, with a spiculation which appears to me, from the illustrations, to be very like that of his *C. stepanowii.*

"Lastly, Mr. H. Mills of Buffalo, in a letter dated 20th. Nov. 1886, sent me a specimen of *Carterius* from the Niagara River which he considers allied to *C. latitenta*, Potts, wherein the expanded portion of this development presents itself under the form of a cup, with even, circular margin, (that is entirely without cirrous ap-

pendages), whose bottom is pierced by the upright tubular part in the usual way; which "form" appears to prevail generally in the statoblasts of this variety."

2) Carterius tubisperma, Mills. Proc. Acad. Nat. Sci. June 1881, p. 150. (Pl. VI, fig. iii.)

Spongilla——Mills. Am. Jour. Micros. June 1880, p. 132.

Sponge brown or green, massive, loose textured; surface wave-like.

Gemmulæ numerous, spherical, relatively large; crust charged with birotulate spicules. Foraminal apertures prolonged into slender, cylindrical tubes, whose greatest length is about equal to the diameter of the gemmule, abruptly flaring at their terminations into several short, inconsequent tendrils of less or greater length. (Pl. VI, fig. iii, a.)

Skeleton spicules rather slender, fasciculate, subfusiform, gradually pointed, sparsely spiniferous; spines small, rounded. (Pl. XII, fig. vi, a.a.)

Dermal spicules long, slender, acerates; generally straight, entirely spined; spines near the middle of the spicules long, cylindrical; terminations rounded. (Ibid. e.e.)

Gemmule birotulates abundant, irregular in length, (suggesting the genus *Hetromeyenia*); shafts cylindrical, sometimes with one or more spines; outer surface of rotules arched; rays numerous, long; terminations incurved (ibid. b.b.b.c.)

Meas. Skeleton spicules 0·0099 by 0·00025 inches. Dermal spicules 0·0038 inches long. Birotulates 0·0019 by 0·00015 inches. Diameter of disk 0·0008 inches.

Hab. On timbers etc.

Loc. Niagara River, New York; Cochituate Reservoir, Boston, Mass. etc.

The original description by Mr. Mills of his species, given as above in June 1880, without specific name is as follows:—

"Sponge low, branching (?) green, growing on the upper surface of stones in not very deep water. Skeleton spiculæ fusiform-acerate, slightly arcuate, moderately stout, spined; spines small, sparsely distributed; length 0·01 to 0·012 inches, apices naked. These are mixed with a great many fine delicate spicula (dermals) densely spined to the end; length 0·009 inches, scattered in groups on each slide of mounted specimens. Ovaria globose; diameter 0·02 inches. Foramen tubed; tube terminating with five (?) finger-like processes

somewhat resembling tentacles. Spicula birotulate, long, very delicate; length of axle 0·0015 inches, one or more large spines on each axle. Rotulæ slightly arcuate, equal in size. Length of tube to foramen 0·01 inches. Length of tentacle shaped processes, one fiftieth to one eightieth of an inch."

(3) **Carterius latitenta**, Potts. Proc. Acad. Nat. Sci. Phila. July 1881, p. 176. (Pl. VI, fig. v,. Pl. XII, fig. v.)

Sponge green, encrusting stones etc.; texture very loose; the longer bands of skeleton spicules rising into abrupt wave-lines at short distances; masses thicker near the middle.

Gemmulæ numerous, spherical; crust charged with birotulate spicules; foramina prolonged into tapering (narrowing) tubules shorter than those of *C. tubisperma*; terminations rounded. Cirrous appendages, at first flat and ribbon-like, enveloping the tubule, (or pierced by it), some distance below its termination; frequently but one, rarely more than two of these, which soon become slender and rounded, long and tapering, occasionally subdividing into many short irregular ones. (Pl. VI, fig. v. a. and d.)

Skeleton spicules fusiform, smooth or very sparsely microspined, gradually pointed. (Pl. XII, fig. v. a.a.)

Dermal spicules long, acerate, slightly curved, entirely spined; spines irregular, longer towards the middle of the spicule. (Ibid. c.c.)

Birotulate spicules stout; shafts with numerous long, pointed spines; surfaces of rotules rounded; rays deeply cut, tapering, sometimes incurved (ibid. b.b.b.d.) (Pl. VI, fig. v. b.)

Meas. Skeleton spicules 0·0111 by 0·00045 inches. Length of dermal spicules 0·0038 inches. Birotulates 0·0019 by 0·00015 inches. Diameter of disk 0·001 inches.

Hab. On stones etc., in rapidly running water.

Loc. Chester Creek, Pennsylvania; Western New York etc.

In the summer of 1881, I resided temporarily in a fine agricultural district in Chester County, Pennsylvania. As a rule, July is, in this part of the world, too early for the collection of mature specimens. Some species, however, form their gemmules thus early; and, while wading along the east branch of Chester Creek, there a shallow stream, averaging eight or ten feet in width, turning over stones in the "riffs," or little rapids, probing the roots of encroaching trees and examining the stems of water plants, I found traces of a sponge, which, under the microscope, proved to be a third species of

Carterius. The gemmules were young, to be sure, but the tendrils were there and the novelty of the species was easily seen.

Further down the stream, where the public road crosses it by an old-fashioned "covered-bridge," in the shelter of it and, incidentally, protected from the trampling of cattle by fences of barbed wire, was found the very headquarters, the "zoological garden" of this species. Nearly every stone and the gravelly bed of the stream between them, was covered with it just under the surface of the water. The masses were not large, say five or six inches in diameter; and while thickest near the middle, tapered off into a delicate nimbus around the edges. This appearance was more conspicuous during the early autumn, when, the thicker portions having become brown with age, a new growth, probably from the germination of some of the older gemmules, had started around the edges, and in this no gemmules could yet be found. Soon after, the bunches began to dwindle in size, and on the day after Christmas of that year, I find it recorded, "the *masses* have all been washed away, leaving a slight muddy incrustation, consisting partially of filiform algæ, with numerous sponge gemmules and their tendrils, which have aided in binding the particles of a deposit of silt or fine mud into a persistent film, that will probably last until the time for germination next spring." The following year the amount of this sponge, in that locality, was much reduced, and since that date I have had no opportunity to examine it.

In common with the other two species, this fresh-water sponge is very loosely held together; with the same conspicuous wave-lines of spicules marking its surface. On the gemmules, the broad ribbon-like tendrils, seemingly pierced by the tapering ends of the foraminal tubules, are in strong contrast with the slender, thread-like filaments of *C. tenosperma*, next to be described; still less do they resemble those inconsequent, almost embryonic, features of *C. tubisperma* and *C.* (*Dosilia*) *stepanowii.* Yet the spicules of this species, skeleton, dermal and birotulate, closely resemble those of *C. tubisperma* and both are suggestive of *H. repens.*

(4) **Carterius tenosperma,** Potts. (Pl. VI, fig. vi; Pl. XII. fig. iv.)

Spongilla tentasperma, Potts. Proc. Acad. Nat: Sci. Phila. July 1880.

Spongilla tenosperma, Potts. Proc. Acad. Nat. Sci. Phila. Nov. 1880, p. 357.

Carterella tenosperma, Potts. Proc. Acad. Nat. Sci. Phila. June 1881, p. 150.

Sponge yellowish-green; creeping upon and around water-plants and roots, matting them together and thus forming loose, irregular masses several inches in diameter, often including shells of *Planorbis* and other snails. Less frequently it is found encrusting the upper surface of stones or the gravelly bed of a stream to the depth of two or three lines. Sponge itself of no describable form.

Gemmulæ spherical, light yellow or brown, rather numerous among the skeleton spiculæ and the attached roots; granular crust charged with birotulate spicules. Foramina sub-elliptically enlarged and prolonged to a length about equal to one fourth the diameter of the gemmule. Just below its rounded termination it gradually flares and divides into two to five tapering, slender, curling or twisted tendrils, whose length may be as much as a half an inch. These cirrous appendages or prolongations of the chitinous coat of the gemmule in this species are generally round, but occasionally, near their origin, are flat for a short distance. (Pl. VI, fig. vi.)

Skeleton spicules slender, subfusiform, gradually pointed, very sparsely microspined. (Pl. XII, fig. iv. a.a.)

Dermal spicules slender, nearly straight acerates, entirely spined; spines longer near the middle of the spicules. (Ibid. d.d.d.)

Birotulate spicules with cylindrical shafts, abundantly spined; spines as long as the rays of the rotules; acutely conical. Rays of supposable rotules numerous, spreading outward like a burr or brush; often with a spinous prolongation in the line of the shaft. (Ibid. b. b. c.c. e.e.)

Meas. Skeleton spicules 0·0098 by 0·00025 inches. Length of dermal spicules 0·0028 inches. Birotulate spicules 0·0018 by 0·0001 inches. Diameter of disk 0·0006 inches.

Hab. As described.

Loc. Lansdowne Run, Centennial Grounds, Philadelphia; Lehigh River, Bethlehem, Pennsylvania; Rahway River, New Jersey, etc.

The visitor to the American Centennial Exposition of 1876, whether foreigner or "to the manner born," if but for a minute he withdrew his eyes from that wonderful display of human art and rested them upon the natural beauties of the landscape in the midst of which it was placed, can hardly even now fail to remember the "Lake" with its ever flowing geyser fountain, lying north of "Machinery Hall." Escaping by a passage under the "Belmont Road," the over-

flow of this pond made its way to the Schuylkill River through the lovely "Lansdowne Glen," filling the little "Run" that, before and since that summer, has but softly murmured through it, with an unfamiliar turmoil of waters. In its normal condition this stream is one a child could step over at almost any point, and all its water could probably be carried through a six-inch pipe.

That portion of it just below Belmont Avenue has become somewhat famous in our local biological annals. It was here that Prof. Leidy found, a year or two after the "Centennial," thousands of colonies of his beautiful Bryozoan, *Cristatella idæ*, covering every stick and stone. Here in 1878 the writer discovered that fragment of *Spongilla fragilis*, which, thus accidentally, directed his attention toward a line of study in which he has since had such great enjoyment; and here two years later was first found the subject of the present memoir, a sponge whose novelty was exhibited in a greater departure from previously known types, than had been the case with any before discovered. *Spongilla tentasperma, S. tenosperma, Carterella tenosperma* and *Carterius tenosperma*, ring the changes in its name and history, till it now stands accepted, I trust, (coincidently with *C. tubisperma* of Mr. Mills,) as the first instance in which the spherical chitinous body of a sponge gemmule has attained a cirrous development, conspicuous in its character and evident in its purpose.

The cirri in this species are very long and slender; curling and twisting in infinite contortions about themselves and the roots among which they grow;—so long, that they have been combed out to an actual length of half an inch, or twenty five times the diameter of the gemmules of which they are parts. More or less of the sponge was found at the same locality for several successive years, until 1885, when, as search was not made until December, its apparent absence was not to be wondered at.

One circumstance not easily explained must be mentioned as a part of its history. The birotulates of those gemmulæ collected in 1880 were peculiar in this,—there were no proper rotules, and the rays at the ends of each spicule stood out in every direction, like the bristles of a mop. On those gathered during the following, and, so far as I remember, during subsequent years, this habit has changed and the rotules in nearly all cases are perfect. The collections were made at precisely the same locality; and in all other respects the sponges appear to be identical.

We have now examined in detail all the genera comprised in the group *Spongillina*, that are clearly characterized by the presence of "seed-like reproductive organs called statoblasts" or gemmules. There yet remain three genera in which no such organs have been discovered. As shown by their geographical derivation, they are as certainly *fresh water sponges* as any of the others, and the absence of the supposed distinctive features, may or may not prove to be real. They have *not yet* been found; that is all. But neither have the sponges been examined at the place of their growth, if we except the *Lubomirskiæ*, by any one familiar with the peculiarities of the fresh water forms, who has torn to pieces mass after mass, as was done in the case of *S. lacustris*, v. *abortiva*, *S. aspinosa*, *H. pictovensis* etc; as must be done in our treatment of all the evergreen sponges, which, probably for the very reason that they live throughout the year, perfect but few gemmules.

I know that it is in the line of my own arguments, already given, to believe it possible that fresh water sponges, living in deep, tropical waters, should not adopt this method of reproduction; and I *do* believe it, *theoretically*. It is necessary however that this theory should be proved by a more thorough and systematic examination, of the genera now to be briefly mentioned, which are neither all tropical nor "deep" in their origin, when, if they maintain their claim, it will be in order to form a new group to comprise them.

Between two of these genera there is a strong family resemblance at least in the forms of their skeleton spicules. Those of the third genus, *Lubomirskia*, as well as the prevailing habit of the species, seem to differ from the others. I regret that I have not been able to find English translations of Dr. Dybowski's descriptions, but can present only the meagre sketches prepared by H. J. Carter from his examination of the plates furnished by the author.

(VIIa.) Prov. Gen. URUGUAYA, Carter.

Uruguaya corallioides, Carter. Ann. and Mag. 1881, p. 100.

Spongilla corallioides, Bowerbank. Proc. Zool. Soc. etc. 1863, p. 460.

Sponge "irregularly digitate; rising into a polychotomous and anastomosing mass of cylindrical branches, which may attain several inches (seven or more) in all directions. Color faint whitish yellow or dark leaden on the surface; internally white or colorless.

Surface even, vitreous in appearance, extremely hard, smooth and compact, interrupted by small raised vents, more or less uniformly

distributed at short and unequal distances from each other. Internal structure composed of short, densely reticulated fibre, formed of the skeleton spicules of the sponge, in bundles firmly united together by colorless sarcode, which, together with the spicules, in a dried state, simulates, from its hardness and vitreous appearance an *entirely* silicified mass. Skeleton-spicule very robust, much curved, cylindrical, rounded at both ends, smooth or microspined, about six times longer than it is broad. Statoblast unknown." Carter.

Loc. "Rapids of the River Uruguay, above the town of Salto, Uruguay."

Several large specimens of this sponge have been collected by different travellers, and are deposited in English museums. Mr. Carter mentions the names of Messrs. George Higgin, W. Bragge, R. M. Andrew, and Dr. Garland in this connection.

(VII b.) **Gen. POTAMOLEPIS**, Marshall.

Zeit. fur Naturwissenchaft, XVI. N. F.IX. Bd. 553. Leipzig, May, 1883.

"Monactinellid, silicious, fresh-water sponges of great brittleness, with curved, obtuse, smooth spicules, which, when dry, are closely cemented together by a small quantity of organic substance. No gemmules." Marshall.

The descriptions of the following species, are abbreviated from a translation of the above paper, as found in the "Ann. and Mag." etc. 1883, p. 391 etc. The specimens examined and described by Dr. Wm. Marshall were collected by Dr. Pechuël-Loesche from the Congo River, Africa, about 150 miles from the sea, and above several "Falls" named.

(1) **Potamolepis leubnitziæ**, Marshall.

"Forming crusts of 1–1·5 millim. thick, finely porous, of yellowish white color and silky lustre; exactly the appearance of unbaked wafers. The surface presents a few crateriform elevations of 0·25–0·40 mm. in height, standing in not very distinctly marked rows, upon faint undulations, which divide dichotomously in both directions and frequently disappear, and in which a certain parallelism is unmistakeable. At the summit of each elevation there is an osculum of irregular elongati-ovate and sometimes elongati-triangular or pentagonal form, separated usually by a space of two millimeters. The mouths, which are usually furnished not with smooth but with finely notched margins, lead into shallow gastric spaces, which immediately break up into several canals; in the *angular* mouths a canal is frequently found at each angle." "These canals run horizon-

tally, branching dichotomously and communicating with those pertaining to the neighboring oscular systems. Incurrent apertures numerous, circular, about 0·1 mm. in diameter, though some are much smaller."

(2) **Potamolepis chartaria**, Marshall.

"Oral cone isolated with round, *entire* margins 0·8–1 mm. in diameter. Incurrent apertures not numerous, 0·1 mm. in breadth. Surface like blotting paper, with a dermal skeleton composed of very delicate, felted, straight acerates 0·08 mm. long. Color of sponge when dry, chocolate-brown."

(3) **Potamolepis pechuëlii**, Marshall.

"Sponge crust-like, with numerous oscular cones 10 mm. high, oval at base; the longer and shorter diameters being about as 2 to 1. These cones are placed in rows in the direction of their longest diameters and are generally inclined at an angle of about 45°. The spicules of the species are more slender and less bent than those of either of the others. The color of the sponge is ash-gray with a silky lustre, and this and the large size of the meshes give it the appearance of coarsely porous pumice-stone." Marshall, abridged.

As before remarked, the skeleton spicules throughout this genus closely resemble those of Uruguaya; both being stout, cylindrical, curved, with hemispherical terminations. I understand Mr. Marshall to say that he would probably have attached his species to Mr. Carter's genus if its title had not been so "inconveniently local."

The reader is referred to Dr. Marshall's paper on these Congo sponges, for many interesting and valuable observations.

(VIIc.) Gen. LUBOMIRSKIA ?

(1) **Lubomirskia baicalensis**, Pallas.

Mr. Carter remarks: "One learns from the figure of this species, that it consisted of long digital processes, about 14 inches long by one half an inch in their greatest diameter; more or less uniformly inflated at short intervals (that is, bullate), but solid throughout. (Dr. Marshall remarks that specimens have been found 60 centimeters, nearly 24 inches, high.) Structure elastic, but not crumbling between the fingers. Color dark gray or olive green. Skeleton spicule curved, fusiform, gradually sharp pointed, spiniferous generally, but especially towards the ends, while in some cases the rest of the shaft is smooth. Parenchyma spicule a smooth, thin acerate."

Carter.

Loc. Lake Baikal, Central Asia.

(2) **Lubomirskia bacillifera**, Dybowski.

Sponge "massive, more or less lobed. Structure much the same as that of the foregoing species, but finer and softer. Color grass-green. Skeleton spicule curved, cylindrical, sometimes fusiform, round at the ends, and spiniferous generally, but more particularly over the ends; sometimes smooth over the rest or middle of the shaft. Parenchyma spicule a small, thin, smooth acerate." Carter.

Loc. Lake Baikal.

(3) **Lubomirskia intermedia**, Dybowski.

Sponge "flat, spreading. Structure like that of *L. baicalensis*, but more tender. Color yellowish or olive-green. Skeleton-spicule curved, fusiform, gradually sharp-pointed, spiniferous generally. Parenchyma spicule a large, smooth acerate." Carter.

Loc. Lake Baikal.

(4) **Lubomirskia papyracea**, Dybowski.

Sponge "papyraceous in thinness, with smooth, shining surface. Structure very soft. Color white. Skeleton thick, (seven times longer than broad), curved, cylindrical, round at the ends, thickly spiniferous throughout. Parenchyma spicule a very small, smooth acerate." Carter.

The above species, described by Dr. W. Dybowski, were collected by his brother Dr. Benedict Dybowski and Herr W. Godleuski, all from Lake Baikal in Siberia. Very many specimens were obtained by them from various depths in the Lake, and the conclusion reached by their intelligent observations was that the sponge was totally devoid of gemmules. I do not know that these observations sufficiently covered the range of the seasons, to make the result positive. The condition of Lake Baikal as a geologically "recent" fresh-water lake, still retaining in its fauna etc., traces of its former marine character, (such as the existence of seals in it or in a recently connected body of water), renders these observations peculiarly important.

CONCLUSION.

In closing this (third) Monograph of the fresh-water sponges, it is with the consciousness that the work of classification occupies a very humble place among biological efforts and that all systems must of necessity be tentative and temporary, soon to be superseded by others, the results of a larger knowledge, gained by the contemplation of a wider horizon. Even so, it has its value in helping forward this very result.

Some points in the present seemingly narrow field of scientfic labor, worthy of the thought and study of future students have already been suggested, such as the *necessity* of gemmules in fresh water as distinguished from marine sponges; the process of their formation; their function and the means by which that end is attained; the law of variation in the quantity and character of the enveloping crust, and the time and mode of formation of the embedded armature;—all have yet to be conclusively studied. Other questions of a more limited character occur, in the search for the line of derivation that must be supposed to run through all the genera and species; and in the association, apparently indicated amongst otherwise dissimilar species, by the presence in them of correspondent forms, such as the birotulate dermals found in certain Spongillas and Meyenias and the more frequent recurrence in several genera, of acerate dermals with characteristic, centrally located, perpendicular spines, etc.

The true meaning of such facts must yet be discovered, and I know of no more hopeful field of labor for a young naturalist, seeking for "new worlds to conquer," than that provided by the fresh-water sponges. The few active workers in this field, in North America, have, thus far, but glanced at a few streams and lakes, mostly in the neighborhoods of Buffalo, Chicago and Philadelphia, and in parts of Florida, Nova Scotia and Newfoundland. There can be little doubt that the rest of the Continent holds many rare prizes in trust for younger and better equipped explorers.

Explanation of Plates.

The magnification used in plates V. and VI. is irregular, as suited the several subjects of the artist. The figures on plates VII to XII inclusive, are uniformly magnified about 200 times and represent the spicules as seen upon prepared slides.

Plate V.

Fig. I. *Spongilla lacustris.* Surface of gemmule showing,–*a*, position and character of "infundibular" foraminal aperture; *b*, *acerate* gemmule spicules, lying upon, or imbedded in, a granular "crust." (See Pl. VII.) The position of these greatly varies in the different "varieties" or "forms," governed generally by the thickness of said "crust."

Fig. II. *Spongilla fragilis.* *A*, upper surface of part of "pavement layer" of gemmules; *a*, foraminal tubules, mostly curved, located at the centre of the upper surface of each gemmule; *b,b*, *acerate* spicules embedded in the "cellular parenchyma" which surrounds and combines the gemmules. (See Pl. VIII.) *B*, section of "group" of "errant" gemmules; *a*, curved foraminal tubules, *always outward; b*, envelope of cellular parenchyma charged with acerate spicules.

Fig. III. *Spongilla igloviformis.* *A*, "elevation" of dome-shaped group of gemmules, showing through the surface of the "cellular parenchyma" which has been made transparent, the several gemmules in position, surrounded by the echinating *acerate* "parenchyma spicules." (Pl. VIII, fig. v.) *B*, the surface (transparent) of a similar group as seen from above. The foraminal apertures, not here visible, all open *inward.*

Fig. IV. *Meyenia leidyi.* *A*, upper surface of portion of a layer of gemmules, each of which, besides its "*birotulate*" armature, (Pl. X, fig. i.) (not shown in this sketch) is surrounded by–*c*, a "lattice capsule" of spicules resembling those of the skeleton; at the summit of which an open space occurs, around–*a*, the foraminal aperture; more than one being sometimes present. *B*, section of part of "chitinous coat" of a gemmule, showing (imperfectly)–*b*, its armature of *birotulate* spicules in position.

Fig. V. *Meyenia fluviatilis.* Surface of gemmule. "Crust" charged with "*birotulate*" spicules (amphidisks); one star-shaped "rotule" resting upon the chitinous coat, the other presented to the observer, or more or less foreshortened. (See Pl. IX, fig. iii, etc.)

Fig. VI. *Meyenia crateriformis.* Section of chitinous coat of gemmule, supporting–*b*, hooked "birotulates" with very long shafts; whose positions, normally radial, are, in this species, frequently twisted or confused. (Pl. X, fig. v.)

PLATE VI.

Fig. I. *Heteromeyenia argyrosperma.* Partial section of "chitinous coat" and "crust" of gemmule, showing:—*a*, the somewhat narrowing "foraminal aperture;" thick "granular crust" charged with–*b*, "long" and–*b*[1], "short" *birotulate* spicules. (Pl. XI, fig. i and ii.) The outer rotules of the longer birotulates, when covered by the crust, form conical protuberances as figured. They are, perhaps, more frequently seen naked.

Fig. II. *Tubella pennsylvanica.* Partial section of chitinous coat of gemmule, surrounded with granular crust; in which are embedded,–*b*, minute, *inæquibirotulate* spicules, (Pl. XII, fig. i, ii, iii.) the larger rotule always resting upon the chitinous coat. The thickness of the "crust," in this species, varies in different localities, from barely equalling the height of the spicules, to the extreme of covering them two or more times that depth.

Fig. III. *Carterius tubisperma.* Partial section of chitinous coat and crust of gemmule; the latter embedding–*b*, birotulate spicules. Foraminal aperture prolonged into a long tubule–*a*, flaring and funnel-shaped at its extremity and divided into several short tendrils or cirrous appendages,–*d*.

Fig. IV. *Carterius stepanowii.* Partial section of gemmule showing protoplasmic contents, crust, birotulate spicules–*b*, foraminal tubule–*a*, penetrating the subquadrangular, flange-like extension–*d*, divided at the angles into numerous very short cirrous appendages. (after Dybowski.)

Fig. V. *Carterius latitenta.* Partial section of chitinous coat, bearing crust, and birotulate spicules–*b*; and extended into a

foraminal tubule shorter than that of either of the previous species, surrounded and terminated by one or two long and broad, ribbon-like cirrous appendages–*d*.

Fig. VI. *Carterius tenosperma.* Section as before; the short tubule –*a*, divided into several long, slender cirrous appendages–*d*.

PLATE VII.

Fig. I. *Spongilla lacustris.* From an Ice Lake, on the Sierra Nevada Mts, alt. 7000 feet:–*a*, skeleton spicule; *b,b,b* bent, cylindrical, *acerate* gemmule spicules; *c,c,c*, spined acerate "dermal" or flesh spicules. Received from Dr. H. W. Harkness, through Miss. M. M. Greer.

Fig. II. *Spongilla lacustris.* From Ridley Creek, near Media, Pennsylvania:–*a,a*, skeleton spicules; *b,b,b*, *acerate* gemmule spicules; *c,c,c*, "dermal" accrates.

Fig. III. *Spongilla lacustris.* From English type, received from H. J. Carter:–*a,a,a*, skeleton spicules; *b,b*, etc. *acerate* gemmule spicules; *c,c*, dermal accrates.

Fig. IV. *Spongilla lacustris.* From May's Landing, New Jersey: –*a,a,a*, skeleton spicules; *b,b*, long, spinous, *acerate* gemmule spicules; *c,c*, small dermal accrates.

Fig. V. *Spongilla lacustris*, var. *lehighensis.* From the Lehigh River, at White Haven, Pennsylvania:–*a,a*, skeleton spicules; *b, b, b*, strongly spinous gemmule spicules; *c,c,c,c*, short dermal accrates.

Fig. VI. *Spongilla lacustris*, var. *montana.* From Lake on Catskill Mts., New York, alt. 2500 feet; representing skeleton and gemmule spicules; no dermals have been drawn.

PLATE VIII.

Fig. I. *Spongilla fragilis.* From *type specimen* "presented by Dr. Jos. Leidy to the Academy of Natural Sciences, Philadelphia:"–*a,a,a,a*, skeleton spicules; *b,b,b,b*, spicules from the "cellular parenchyma."

Fig. II. *Spongilla fragilis*, var. *minutissima.* From Lake Hopatcong, New Jersey:–*a,a*, skeleton spicules; *b,b*, spined forms sometimes seen; *c,c,c*, long, irregular, spinous parenchymal spicules.

Fig. III. *Spongilla fragilis.* From Calumet River, Illinois:—*a,a,* skeleton spicules; *b, c, d, e,* variable parenchymal spicules; *f,f,f,* spined, spherical forms frequently seen throughout the species. Collected by B. W. Thomas.

Fig. IV. *Spongilla fragilis,* var. *minuta.* From Lehigh Gap, Pennsylvania:—*a,a,a,* skeleton spicules; *b,b,b,* long, spined, acuminate, "parenchymal spicules;" *c,c,c,* spherical and amorphous forms.

Fig. V. *Spongilla igloviformis.* From Doughty's Pond, Absecum, New Jersey:—*a, a, c,* skeleton spicules; *b,b,* "parenchymal spicules" nearly equally long, but more spinous.

Fig. VI. *Spongilla aspinosa.* From Doughty's Pond, Absecum, New Jersey:—*a,* ordinary skeleton spicule; *b,* skeleton spicule; *acuate* or rounded at one end; *c, d,* malformations of skeleton spicules; *e,e,e,* smooth dermal spicules; *f,f,f,* globular or discoidal masses of silica, frequently observed in this species.

PLATE IX.

Fig. I. *Meyenia fluviatilis.* From an English type, received from H. J. Carter:—*a* and *b,* spined skeleton spicules; *c,* smooth do.; *d,d,d, birotulate* gemmule spicules sometimes with acuminate umbos; *e,e,e,* end view of rotules.

Fig. II. *Meyenia fluviatilis* var. *acuminata.* From Boston, Massachusetts:—*a,* ordinary skeleton spicule; *b,b,* slender forms of do.; *c,c,d,d,* acuminate or misshapen birotulate gemmule spicules.

Fig. III. *Meyenia fluviatilis,* form *astrosperma,* syn. From Lehigh Gap, Pennsylvania:—*a,a,* skeleton spicules; *b,b,* birotulate gemmule spicules; *d,d,* malformed do.; *c,* group of rotulæ; *e,e,* single rotules showing an ordinary distribution of the rays.

Fig. IV. *Meyenia fluviatilis.* From Chester Creek, near Lenni, Pennsylvania:—*a,* proper skeleton spicule; *b,* malformed do.; *d,d,d,* short, robust birotulates; *c,c,c* rotules with symmetrical, conical rays, sub-spined at margins; *e,e,e,e,* malformations of birotulates, frequent in this specimen.

Fig. V. *Meyenia robusta.* From Honey Lake Valley, California;—*a, a,* smooth skeleton spicules; *b,b,b,* coarsely spined gem-

mule birotulates; *d,d,d,* single rotules; *c,e,e,e,* exceedingly misshapen forms. Collected by Dr. Geo. H. Horn.

Fig. VI. *Meyenia subdivisa.* From St. John's River, near Palatka, Florida:–*a,* smooth, *b, c, d,* spined skeleton spicules; *e,e, e,e,* long, massive gemmule birotulates, spined and sub-spined; *f,f,* rotules of do. Collected by Henry Mills.

PLATE X.

Fig. I. *Meyenia leidyi.* From Schuylkill River, Philadelphia, Pennsylvania:–*a,a,a,* smooth skeleton spicules, abruptly pointed; *b,b,* do. with rounded terminations; *c,c,* short birotulates with "entire" margins; *d,* do. with rotule twisted or exflected; *e,* face of rotule; *f,* group of rotules as they appear upon the surface of the gemmules.

Fig. II. *Meyenia millsii.* From Florida:–*a,* microspined skeleton spicule; *b,b,* mature gemmule birotulates with smooth shafts; *c,c,c,* probably immature forms; *d,d,d,* face of rotules, "lacinulate" or delicately notched, and without rays. Collected by H. Mills;

Fig. III. *Meyenia everetti.* From Pictou, Nova Scotia:–*a, a, a, a,* smooth, slender skeleton spicules; *b,b,b,b,* long smooth, *gemmule* birotulates; *c,c, d,d,* minute *dermal birotulates.* Collected by A. H. MacKay.

Fig. IV. *Meyenia everetti.* From Gilder Pond, on Mt. Everett, Massachusetts:–*a,a,b,b,* smooth skeleton spicules; *c, c, c gemmule* birotulates; *d,* end view of rotule formed of hooked rays; *e,e,e,* minute *dermal birotulates.* Collected F. Wolle and H. S. Kitchell.

Fig. V. *Meyenia crateriformis.* From Crowe's Mill, Brandywine Creek, Pennsylvania:–*a,a,* slender, microspined skeleton spicules; *b,b,b,b,* mature gemmule birotulates with short hooked rays; *c,d,e,e,* supposed immature forms.

Fig. VI. *Meyenia plumosa,* var. *palmeri.* From the Colorado of the West, Mexico:–*a,* robust, microspined skeleton spicule; *b,c,c* spined gemmule birotulates; *d,d,* rotules of do., irregularly notched; *e,e,e,* sub-stellate dermal spicules; *f.* imperfect form of do.; *g,g,* amorphous, "Scotch terrier" forms.

PLATE XI.

Fig. I. *Heteromeyenia argyrosperma.* From Lehigh Gap, Pennsylvania:–*a,a,* sparsely microspined skeleton spicules; *b,*

b,b, gemmule birotulates of the *longer class*, with one to three hooked rays; *c,c,c,c*, spined birotulates of the *shorter class*.

Fig. II. *Heteromeyenia argyrosperma*, var. *tenuis*. From Harvey's Lake, Pennsylvania:—*a,a,a*, slender skeleton spicules; *b,b,b* *long* birotulates; *c,c*, birotulates of the *shorter class;* all more slender than in the typical species; *d*, imperfect do.

Fig. III. *Heteromeyenia repens*. From Lehigh Gap, Pennsylvania:—*a,a,a*, microspined skeleton spicules; *b,b*, gemmule birotulates of the *longer* class, with recurved, hooked rays; *c,c,c*, gemmule birotulates of the *shorter* class; *d,d,d*, rotules of do., *e,e*, dermal spicules; *f*. amorphous spicule.

Fig. IV. *Heteromeyenia ryderi*, var. *baleni*. From near Plainfield, New Jersey:—*a,a,a,a*, slender, microspined, skeleton spicules; *b,b,b*, *long*, hooked, gemmule birotulates; *c,c,c*, *short* do; with flat rotules; *d,d,d*, surface of last named. Collected by A. D. Balen.

Fig. V. *Heteromeyenia ryderi*, type. From Indian Run, Philadelphia, Pennsylvania:—*a*, skeleton spicule; *b,b,b*, *long* gemmule birotulates, hooked and spined; *c,c,c,c,c*, *short* birotulates; *d,d,d*, surface of rotules, margins lacinulate, surface microspined or granulated; *e*, amorphous spicule.

Fig. VI. *Heteromeyenia ryderi*, var. *pictovensis*. From Pictou, Nova Scotia:—*a,b,c*, densely spinous skeleton spicules, various terminations; *d,d,d*, *long* gemmule birotulates; *e,e,e,e*, *short* do.

PLATE XII.

Fig. I. *Tubella pennsylvanica*. Lehigh Gap, Pennsylvania:—*a,a,a,a*, spined skeleton spicules; *b,b,b*, gemmule "inæquibirotulates," or trumpet-shaped spicules; *c*, group of rotules seen from above, showing the relative sizes of the rotules; *d*, surface of single large rotule.

Fig. II. *Tubella pennsylvanica*, var. *intermedia*. From Indian Run, Philadelphia:—*a,a,a*, stouter skeleton spicules; *b,c,c*, "inæquibirotulates;" *d,e,e*, end view of do. showing comparative size of rotules in this variety.

Fig. III. *Tubella pennsylvanica*, var. *fanshawei*. From Bristol Pond, Pennsylvania:—*a,a,b,b*, skeleton spicules; *c,c,d,d*, birot-

ulates more nearly equal than in either of the former cases, as shown again by–*f,f,g,g*, end views.

Fig. IV. *Carterius tenosperma*. From Lansdowne Run, Philadelphia, Pennsylvania:–*a,a*, skeleton spicules; *b,b,b,c*, spined gemmule birotulates with burr-like rotules; *e,e,e*, ends of do.; *d,d,d,d*, long, spinous, acerate dermal spicules.

Fig. V. *Carterius latitenta*. From Chester Creek, Pennsylvania:–*a,a*, skeleton spicules; *b,b,b,b*, gemmule birotulates, variable in length; *d,d*, face of rotules; *c*, spined *dermals*.

Fig. VI. *Carterius tubisperma*. From Niagara River, near Buffalo, New York:–*a,a*, skeleton spicules; *b,b,b,b,b,d*, gemmule birotulates; *c*, face of rotule; *e,e*, long, spined dermal acerates. Collected by Henry Mills.

June 7.

Mr. Thomas Meehan, Vice-President, in the chair.

Twenty-one persons present.

June 14.

Dr. W. S. W. Ruschenberger, in the chair.

Twenty-five persons present.

The following papers were presented for publication:—

"On the structure and Classification of Mesozoic Mammalia." (Abstract). By Henry F. Osborn.

"Notes on the Specific Names of certain North American Fishes." By Carl H. Eigenmann.

June 21.

Mr. Thomas Meehan, Vice-President, in the chair.

Twenty-nine persons present.

Note on Chionanthus.—Mr. Thomas Meehan remarked that *Chionanthus*, L., until recently has been described as having perfect flowers. Of many authors to hand Dr. Gray only, notes, in the later edition of his Manual that it is occasionally polygamous.

It is rather one of those plants that are on the border-land of diœcism which, while having flowers apparently alike on all plants, have impotent anthers with a perfect pistil in one individual, and polliniferous anthers and an imperfect pistil in the other. The plant is therefore actually diœcious, while having flowers apparently perfect. This is certainly the rule.

There is, however, a great difference in the flowers when critically examined. All authors he had referred to describe the pistil as "emarginate or "bifid."

This is only the case in what we must call the male plant. (Fig. 1.) In the female it is capitate. (Fig. 2.) The anthers in the male are broadly ovate, barely pointed, thick, and of an uniform eburnean tint, with an abundance of yellow pollen. In the female they are linear ovate, greenish white with a mucronate, almost awned point, never polliniferous, and usually have more slender filaments.

Fig. 1.

No author seems to have noted the capitate stigma. Probably

the male plants are more abundant, and come more readily to hand.

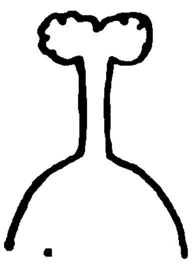

Fig 2.

Of eleven he had out in a swamp to bear seed, before being aware of its bi-sexual character, only three are berry-bearing, and have the capitate stigma that characterizes the female flowers. On his lawn there is a large plant, isolated from others, with capitate stigmas, that has never borne a seed. He had an impression that he had seen single specimens in cultivation, in years gone by, with seed, so it is not improbable, under rare exceptions, a plant may have actually perfect flowers.

An interesting fact is that the usual description of "anthers, sometimes 3 or 4" is correct only as applicable to the male plant; this increase in the normal number is there frequent. He had not been able to find more than two in the female.

Although the white flowers are conspicuous, and the males have a delicate fragrance, he had not known them to be visited by bees or other insect, except the minute pollen eating thrips found in most flowers.

This may be from the abundance of other flowers on his grounds, at the time when these plants are in blossom. Industrious as bees are, they visit those flowers first that have nectar and pollen in profusion, in preference to gleaning in scant fields, taking to these only when abundant crops are scarce. The pollen is granulous, and fertilization is evidently effected through the wind. The flowers are therefore anemophilous.

June 28.

Mr. Charles Roberts, in the chair.

Fourteen persons present.

A paper entitled "On the Structure and Classification of the Mesozoic Mammalia," by Henry F. Osborn, was presented for publication,

Mr. Theo. Wernwag, was elected a member.

The following was ordered to be printed:—

ON THE STRUCTURE AND CLASSIFICATION OF THE MESOZOIC MAMMALIA.

BY DR. HENRY F. OSBORN.

[ABSTRACT.]

This paper is an outline of the writer's observations upon the structure of the British Mesozoic Mammals and a classification of the Mesozoic Mammals in general, in view of their relationship to each other and to recent orders.

When Professor Owen completed his Memoir[1] in 1871 there were but twenty genera of pre-Tertiary Mammals known to science. Discoveries in the Mesozoic strata of Germany,[2] South Africa[3] and North America[4] have now increased this number to over forty genera, five of which are from the Upper Triassic, the remainder from the upper and lower Jurassic, and one from the Cretaceous.[5] Successors of the Mesozoic mammals have been discovered at the bottom of the American Eocene[6] and in the lower French Eocene Beds.[7] Among the latter are mammals which clearly connect upper Triassic[8] with Quaternary genera.[9] Through the kindness of the members of the Geological Department of the British Museum I was recently enabled to study the British types very carefully, and, enjoying soon afterwards an examination of the fine collections of Professor Marsh and Professor Cope,[10] I have been able to compare the type specimens of all the Mesozoic mammals, with the exception of four genera.[11] The most striking result of this comparison is the

1. Monograph of the Fossil Mammalia of the Mesozoic Formations, Palaeontographical Society, 1871.

2. *Triglyphus*, discovered by Prof. Fraas in the Rhaetic Beds near Stuttgart.

3. *Tritylodon*, from the Stormberg Beds, Upper Triassic, South Africa.

4. Numerous genera discovered by Prof. Marsh in the Atlantosaurus Beds parallel with the English Purbeck.

5. *Meniscoëssus*, described by Professor Cope, from the Laramie Beds.

6. I refer to Professor Cope's genera *Polymastodon*, *Chirox* and *Ptilodus*.

7. The *Plagiaulax* group, discovered by Dr. Lemoine at Rheims.

8. *Microlestes* and 9 *Thylacoleo* are united by the intermediate *Plagiaulacidae*.

10. This assistance will be more fully acknowledged elsewhere. I am especially indebted to Mr. Richard Lydekker for much valuable assistance.

11. *Stereognathus*, *Amphilestes*, *Triglyphus*, *Microlestes antiquus* (Plieninger's type specimen.)

Full acknowledgement will be made later of the use made of the valuable suggestions of Professor Owen and other writers.

close structural similarity between genera from widely separate localities, and the absence of types which are wholly distinct from the British, even in this greatly extended field of exploration. In other words, the Mesozoic genera appear to have had a very wide geographical distribution, and many scattered forms, while generically distinct, are closely connected by family and ordinal characters. The second result, which has been attained much more slowly, is that these mammals, with a few exceptions, can now be provisionally classified, as they fall into small groups with carnivorous, omnivorous, insectivorous, and herbivorous dentition, each with clearly marked characters. The third result which rests upon more debatable grounds is, that while many of these Mesozoic families became extinct in succeeding geological periods, many others belong in or near the ancestral lines of families still existing among the Marsupials and Insectivores.

Before entering the subject of classification I will give a brief resumè of my observations upon the British genera in so far as they differ from, or are additional to those of Professor Owen. It appears, from the dentition of a mandibular ramus belonging to *Amphitherium* which has been recently added to the British Museum collection, that three distinct genera have hitherto been included under this genus, which may be separated by the number of premolars, by the conformation of the molar crowns and the form and positions of the condyle, as *Amphitherium*, *Amphitylus* and *Amphilestes*.[1] (2) *Phascolotherium*. The formula is i 4 c 1 pm 0 m 7. It seems more probable that this genus has lost its premolars, (which formerly may have filled the diastema), than that they should all have become molariform, a modification which is always slowly acquired. (3) *Triconodon*. The upper canine of this genus has a double fang. The most interesting fact brought out is the evidence the various specimens furnish of relationship to the Marsupials in the succession of the teeth.[2] The fully adult molar formula is pm 4 m 4. The fourth

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1. The *Amphitherium* (A. Prevostii) molar is bicuspidate with a low posterior heel. The *Amphitylus* (*gen. nov.*) molar has three blunt cusps, and an internal cingulum; form, *pm* 6, *m* 6. The *Amphilestes* molar has three prominent cusps and a pronounced cingulum, encircling the crown; *pm* 5, *m* 6. After a personal examination of the types, Mr. Lydekker writes me (April 16th) that he finds the formulae of both *Amphilestes* and *Amphitylus*, as follows: *i* 4 *c* 1 *pm* 4 *m* 7.

2. Assisted by Mr. Lydekker, I have confirmed the suggestions of Professor Owen and Professor Flower.

premolar early replaces a *molariform milk* tooth d_4 and the fourth true molar is very late in coming in. *Triacanthodon* is thus a synonym of *Triconodon*. (4) *Phascolestes*. There is no doubt that this genus is distinct from *Peralestes*,[3] but it is a question whether the type mandible does not belong to a genus near *Stylodon*. Form. i 4 c 1 pm 4 m 8. (5) *Leptocladus*, is widely separate from *Stylodon*.[4] Its molars, with single recurved cusps and elevated heels are wholly unique. The post-canine formula was probably pm 4 m 6. (6) *Peramus* is also widely separated from other genera in its dental formula, pm 6 m 3; all other polyprotodont genera of this period having four or more molars. The teeth in the type of this genus are seen upon the outer surface only. It is probable that when the inner surface is known, the formula will be modified to pm 4 m 5. (7) In the genus *Spalacotherium* the molars and premolars are well differentiated; the formula is i ? 2, c 1, pm 4, m 6. (8) *Peralestes* probably has a closely related form in *Peraspalax*, in fact the generic distinctness of the latter is doubtful. The post-canine formulæ are, *Peralestes* pm 5 m 6; *Peraspalax*, pm 4, m 7. (9) The maxilla which was referred to the genus *Stylodon* by Professor Owen, must be removed to a distinct genus, *Athrodon*, characterized by the compact position and peculiar wearing pattern of the crowns. (10) The maxillary formula of *Bolodon* is found to be i ? 2, c 0, pm 3, m 4. The characters of these teeth are clearly shown in the accompanying cut.

Leaving out of view for the present, all consideration of relationships to recent forms, we find that the Mesozoic Mammalia divide into two larger groups. In the first group (I) one of the incisors is greatly developed at the expense of the others and of the canine; there is a diastema varying in width in front of the first premolar and the true molars are invariably characterized by two or more antero-posterior rows of tubercles separated by longitudinal valleys or grooves. For this group we may adopt the sub-order *Multituberculata*, proposed by Professor Cope.[5]

The second group (II) does not show such close internal relationship among its members as does the foregoing, but is well separated from it by such characters as the following:

The incisors are numerous and subequal in size, the canines are

3. Professor Owen separated this genus doubtfully from *Peralestes*.

4. Professor Owen placed it doubtfully near this genus.

5. American Naturalist, 1884, p. 637.

large; there is usually no diastema, the premolar-molar series are usually in excess of the typical number and the molars are cusped rather than tubercular. If we were sure of the marsupial relationship of the members of this group we might place them with the sub-order *Polyprotodonta*, but some of the included families belong near the Insectivora.

I. Multituberculata.

(1) *Plagiaulacidæ.* This is probably the oldest family of this group and is well characterized by the laterally compressed trenchant premolars. The molars of *Microlestes antiquus* of Plieninger are essentially similar to those of *Plagiaulax*. The *M. Moorei* molars cannot be distinguished generically from those of *Plagiaulax*.[6] The least specialized *Plagiaulax* is *Ctenacodon*, Marsh.[1] The modifications in this family are well known as witnessed in the series *Plagiaulax, Ptilodus, Neoplagiaulax.*

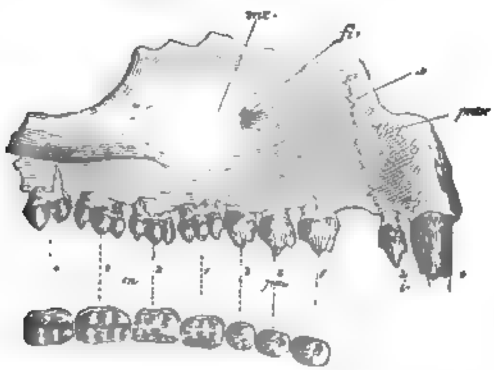

Fig. 1. Right Maxilla of Bolodon.

(2) *Bolodontidæ.* This family includes *Bolodon* and *Allodon* Marsh.[2] The premolars are not trenchant. The molars have two straight rows of conical tubercles separated by a longitudinal valley. Although allied to the *Plagiaulacidæ* we cannot place these genera in this family because the molar pattern is essentially different.

6. The molars of *M. Antiquus*, *M. Moorei* and *P. Minor* in each case show a closely similar disposition of the tubercles

1. Am. Journ. Sc. and Arts, Nov. 1879, p. 238.

2. This genus is very close to *Bolodon* in all the details of tooth structure, but shows the alveolus of a small median incisor which may be wanting in *Bolodon*. *Allodon* has been placed in the Plagiaulacidae by Professor Marsh, Am. Journ. Sc. and Arts, April 1887, p. 329.

Bolodon has conical tubercular instead of trenchant premolars. In *Plagiaulax* the tubercles are irregular crenations of the border of the basin shaped crown. In *Bolodon* they are minute, sharply defined cones arranged in straight rows with a deeply worn groove between them; this pattern is like that of *Tritylodon* with two rows of tubercles instead of three.

The general likeness between *Bolodon* and *Tritylodon* is very striking in spite of the great discrepancy in size. The latter genus is perhaps synonymous with *Triglyphus*[4] (Fraas) and forms the type of the family (3) *Tritylodontidae*[1] (Cope), characterized by the absence of trenchant premolars and the presence of upper molars with three parallel rows of tubercles separated by grooves. The *Poly mastodontidæ* (Cope) forms a fourth, more recent family[1].

The position of *Stereognathus*, *Chirox* and *Meniscoëssus* is uncertain, although they probably belong to this Sub-Order. *Meniscœssus* stands nearest the *Plagiaulacidae*, and *Chirox* intermediate between the *Bolodontidae* and *Tritylodontidae*.

II. Second Group.

1. JURASSIC MAMMALS.

Among the second group of mammals I find that the molar pattern forms an advantageous starting point for classification. Contrary to the usual statement, the premolars are invariably unlike the molars[2], but the whole dental series, as well as the mandible, are in a marked degree correlative in structure and in most instances distinctly specialized for certain kinds of diet. Some of the molar patterns with the correlated structures, prevail in a number of genera which we may group in a family, without knowing exactly where to place it in the zoölogical scale. The molars of other genera are transitional in structure between two distinct types. Other genera again are entirely isolated in their molar structure where no allied forms have been discovered. This classification by families is, of course, a temporary one, subject to change as the genera become more fully known. The *Stylodontidae* form the only fully defined family.

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4. See Neumayr. Neues Jahrbuch für Min. u. Pal. 1884, p. 279.

1. Am. Naturalist, 1884.

2. *Phascolotherium* forms an apparent but not real exception, since the premolars have probably disappeared. In *Diplocynodon*. (Marsh, loc. cit. Plate x), the premolars when viewed upon the inner surface are very distinct from the molars.

The chief molar types which characterize families are as follows:

A. Without opposition of cusps. (1) With three stout, erect cusps in line. (2) Transitional. With three cusps not in line, two being rotated inwards. (3) With three slender, divergent cusps in line. *B. With completely opposed cusps, separated by a longitudinal valley.* (4) *C. With completely opposed cusps connected by transverse ridges.* (5) Molars with a single styloid cusp on one side of the crown connected by divergent ridges with a pair of cusps on the other side. *D. Without cusps.* (6) The crowns columnar, with a smooth wearing surface.

By a careful study of the dentition and mandibular structure, we find that these families unite in small groups which are *in early stages of differentiation along certain lines of functional adaptation.* These lines are not sharply defined, but by a comparison of the typical forms with the most nearly allied genera of known adaptation I find we may divide these sub-groups into carnivorous, omnivorous insectivorous and herbivorous series; employing these terms in a broad sense as indicating an initial rather than an advanced specialization of structure.

CARNIVOROUS SUB-GROUP.

There are many points of resemblance between the following three families, although at first sight they differ widely. They mostly embrace the largest genera and the teeth are generally adapted to a carnivorous diet, especially in the first and second families; in the third there is an apparent divergence towards another type of dentition and function. The molars have a strong internal cingulum. The premolars have basal cusps. The condyle is low and the coronoid broad.

A. (1) *Triconodontidæ.*[1] The typical genus of this family is *Triconodon* (*syn. Triacanthodon*, Owen; *Priacodon*, Marsh.) The dentition is now fully known. There is no diastema. The premolars have strong basal cusps. The canines and the incisors are erect and powerful. The mandible is strong and the condyle is below the molar level. These characters and the likeness to *Thylacinus* show that this was a carnivorous animal. An older and much less specialized but probably allied form was *Amphilestes*. *Amphitylus* appears to be related by the character of its molars, but separated by its mandibular characters, as the condyle is high and pedunculate.

1. Proposed by Professor Marsh.

Amphitherium, on the other hand is allied by the structure of the

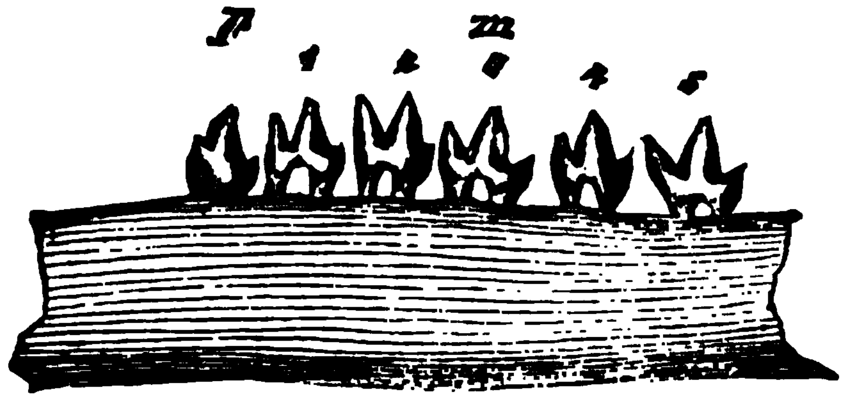

Fig. 2. Portion of the right mandible of Amphitherium.

mandible and separated by the pattern of the molars, which lack the third cusp. The last two genera are somewhat isolated.

(1*a*) An allied family is the *Phascolotheridae*[2] embracing *Phascolotherium* and *Tinodon*, in which there is a diastema behind the canine; true premolars are few or wanting[3], and the mandibular angle is represented merely by the inflection of the lower border. The molars are like those of the *Triconodontidae* except that the anterior and posterior cusps are smaller and are slightly rotated inwards.

(2) *Spalacotheridae*[1]. This family embraces *Spalacotherium* and *Menacodon*. The mandible is without a distinct angle, like that in *Phascolotherium*, but shallower and with a more elevated condyle. There is no diastema. The incisors and canines are somewhat similar to those of *Triconodon*. The premolars have strong anterior and posterior basal cusps. The anterior and posterior cusps of the molars are strongly rotated inwards.

Omnivorous Sub-Group.

B. The families embraced in this division are quite closely inter-related both as regards their dentition and diet. The genera vary from middle to large size. The typical forms (*Peralestidae*) were probably omnivorous. The incisors are not known, the canines are large and erect, the premolars have prominent basal cusps. Instead of an internal cingulum, the lower molars have a more or less prominent internal row of low cusps. The condyle is usually on or below the molar level.

2. This name is preferable to *Tinodontidae* recently proposed by Professor Marsh, since Prof. Owen's genus is much the best known. It is quite probable that the *Phascolotheridae* will be subsequently united with the *Triconodontidae*, linked by intermediate forms with premolars.

3. The post-canine teeth of *Tinodon* have not as yet been fully described.

1. This family name was proposed by Professor Marsh, loc. cit. p. 340.

The (4) *Peralestidae* embrace *Peralestes* and *Peraspalax* which are closely related if not synonymous. The lower premolars have distinct basal cups. The inner and outer molar cusps, instead of being united by a ridge as in the last, are separated by a longitudinal valley. The upper molars (*Peralestes*) have a lofty internal and several low external cusps, while the lower molars, (*Peraspalax*) have a high external and low internal cusps. The canines are strong. The lower molars are somewhat simpler but resemble those of *Dasyurus* and *Didelphys*. I infer that, like these modern marsupials, these animals were omnivorous.

The lower molars of the highly specialized genus *Paurodon*, the type of the *Paurodontidae* (Marsh), although fewer in number, are quite similar to those of *Peraspalax* and suggest an affiliation of these two families.

The *Diplocynodontidae* (Marsh) embrace *Diplocynodon*, *Docodon*, and *Enneodon*. The molars are transitional, illustrating the extension of the internal cingulum into a broad shelf leading towards a complete opposition of cusps such as we observe in *Peraspalax*, but it is as yet uncertain whether this family is affiliated to the *Peralestidae*. This family probably embraces Professor Owen's genus *Peramus*, in which the molar and mandibular structure is similar to that of *Diplocynodon*.

INSECTIVOROUS SUB-GROUP.

The two following families differ widely from those preceding. The genera vary from an extremely small to middle size. The teeth are adapted to an insectivorous diet, the incisors in the most typical forms being procumbent and spatulate, the canines small, the premolars lack distinct basal cusps, the last is lofty and pointed. The molars have no cingulum. The condyle is high and the coronoid slender. The formula is usually *pm* 4 *m* 8. The families are separated by the structure of the molars.[2]

(3) *Amblotheridae*. This embraces the genera *Achyrodon* and *Amblotherium*. The mandible is very slender and tapers to the symphysis, with a high condyle. The incisors are semi-procumbent and spatulate, the canines small, the last premolars very lofty

2. *Amblotherium* and *Achyrodon* are represented by mandibles seen upon the inner surface only. In the matrix impressions there is no evidence of outer cusps, but the teeth closely resemble those of the *Stylodontidae* as seen upon the inner surface, and these families may prove to be the same.

and without basal cusps, while the molars have no internal cingula and no opposition of cusps.

C. (5) *Stylodontidae*[1]. Thanks to the discoveries of Professor Marsh, this family is now very fully represented and the molar structure is well understood. It embraces *Stylodon* (Stylacodon)[2], *Aesthenodon*, *Laodon* and *Dryolestes* which is very similar to the genus *Phascolestes* (Owen.) There is little doubt therefore that the latter genus belongs here rather than near *Peralestes*. The resemblance of *Stylodon* to *Chrysochloris*, observed by Professor Owen, is very much strengthened by this extended knowledge of the *Stylodon* molars, and indicates that this family was insectivorous. The structure of the mandible is very similar to that of *Amblotherium*.

HERBIVOROUS SUB-GROUP.

D. The single family embraced in this division is widely separated from all which precede it. The structure of the molars indicates an herbivorous diet similar to that of the Rodents and the Wombats.

(6) *Athrodontidae*. *Athrodon*[3] is unique in its dentition among the Mesozoic mammals. The tall trihedral crowns are closely applied at their sides, thus falling into a curve. The inner face is styloid, while the outer is grooved and the triangular wearing surface is traversed by a faint median ridge, thus resembling one half the crown of a *Phascolomys* molar. The last premolar is transforming into a molar, the others are small. The canine is large and bifanged.

The genus *Leptocladus* is isolated.

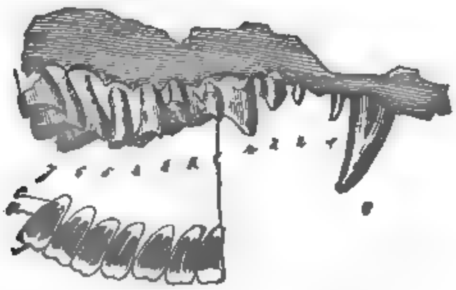

Fig. 3. The inner surface of the left maxilla of Athrodon.

1. This family name was suggested by Professor Marsh in 1880 to embrace *Stylodon* and *Stylacodon*. It is probably equivalent to the *Dryolestidae* more recently proposed by the same author

2. These genera appear to be the same.

3. Gen. Nov. Type, maxilla of *Stylodon pusillus*, Owen.

TRIASSIC MAMMALS.

Dromatherium is widely aberrant, and is the most reptilian in appearance of all the Mesozoic genera. Professor Marsh has proposed the family *Dromatheridae* to embrace this genus, but without defining it. Uniting it with *Microconodon*, the family may be characterized by the imperfect division of the fangs of the molars and the wide diastema behind the canine. The reptilian (Theromorph) condition of the molar fangs may be found to separate these genera still more widely from the jurassic forms so as to represent a new order of mammals, the *Protodonta*.

Conclusion.

It is now generally admitted that many of the genera embraced in the *Multituberculata* were Marsupials, and on many grounds it is safe to place this group as a Sub-Order of the Marsupialia. Are the Jurassic members of the second group also to be placed in this order or do they form a distinct order by themselves? Professor Marsh in his recent view of the Mesozoic mammals has held the latter view. It is, however, impossible to find a single common character[1] or set of characters for these genera which is of ordinal value. On the other hand, there are many grounds for placing the *Triconodontidae*, *Peralestidae* and *Athrodontidae*, and their affiliated families, in or near the ancestral lines of the modern *Dasyuridae* and *Phascolomidae* respectively, while the *Stylodontidae* are similarly related to the *Chrysochloridae*. These grounds may be partially stated. What holds good of one genus is naturally true of all the genera which are clearly allied to it. (1) *Triconodon* has one more premolar but otherwise resembles *Thylacinus* both in the structure of the mandible and in the form and succession of the teeth. (2) *Peraspalax*, although much more imperfectly known, is allied to *Dasyurus* in its molar structure. (3) *Athrodon*, although differing from *Phascolomys* in the possession of a large canine, shows a marked resemblance to this genus in the molar structure. We may designate the allied carnivorous, omnivorous and herbivorous sub-groups as proto-Marsupialia, a sub-order distinguished by the almost invariable presence of four premolars, a number unknown among modern Marsupials.

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1. The mylohyoid groove is universally present, but is also found in *Myrmecobius*.

In the *Amblotheridae* and *Stylodontidae* we probably have a line of Insectivora. (4) *Dryolestes* has a molar pattern which is not observed in any marsupial, but is seen in *Chrysochloris* among the Insectivora. Since, however, it is common for marsupials to mimic the dentition of other orders, this relationship must be held with some reserve.

JULY 12.

Mr. CHARLES MORRIS, in the chair.

Nine persons present.

JULY 19.

Mr. THOMAS MEEHAN, Vice-President, in the chair.

Nine persons present.

AUGUST 2.

Mr. CHARLES MORRIS, in the chair.

Eight persons present.

AUGUST 9.

Dr. W. S. W. RUSCHENBERGER, in the chair.

Eleven persons present.

The Publication Committee reported in favor of publishing a paper entitled "On the Structure and Classification of Mesozoic Mammalia," by Henry F. Osborn, in the Journal of the Academy.

On an Aquatic Larva and its Case:—The following from Miss Adele M. Fielde, dated Swatow, China, April 25, 1887 was read:—

During last January, I found on the level surface of the coarse sand which covers the bottom of an aqueduct near here, under an inch or two of clear running water, little structures resembling a gray net spread to catch fish, or a tiny cave with a gauze awning stretched over the entrance. The arches had a span of from an eighth to a half an inch and always opened toward the current. They were to be seen in scores, with a buttress of coarse sand in the rear, and a minute aperture in the floor. The force of the stream had in a few cases swept away the buttress leaving the arch of gauze, with gray filaments, streaming from its torn hinder edge. The occupant of the wee grotto was in every case a caterpillar, not more than five-eighths of an inch long. It burrowed in the sand of of the floor, stretched its head forth vertically, and fed upon what had been caught in the delicate roof of its den.

Its head, and the three thoracic segments, each of which bore a pair of four jointed legs ending in two hooks, were of a glossy brown, while the following eight segments were either gray or green, and the terminal segment translucent white. The terminal segment

bore two cylindrical prongs, each ending in a tuft of hairs, and having underneath a brown claw, like those on all the feet. Eight segments, beginning with the metathoracic, and ending with the third from the last, bore on the ventral surface two tufts of white tracheal gills, which issued from the body in a single stem and then branched irregularly in several finger-shaped processes, in such fashion as to give the effect of four longitudinal rows of gills along the ventral side.

This small cave-dweller seems to be near akin to those found by Miss C. H. Clarke, in Stony Creek, Mass. and described by her in a "Description of two interesting houses made by caddis-fly larvæ," in the Proceedings of the Boston Society of Natural History, May 24, 1882. It is also similar to a species of *Hydropsyche*, previously described by Dr. Müller, in Southern Brazil.

From hektograph copies sent to me by Miss Clarke, of drawings made by Dr. Müller, I conclude that some free floating larva houses, vase-shaped, translucent, less than a quarter of an inch long, and with four crenulated floats, found by me here at Swatow, are identical with the *Lagenopsyche Spirogyræ*, found by Dr. Müller in Southern Brazil. It seems that these minute Hydroptilidæ, inhabiting different continents, continue to have their cradles precisely alike.

AUGUST 16.

Mr. CHARLES MORRIS, in the chair.

Nine persons present.

A paper entitled "On the Homologies and Early History of the Limbs of Vertebrates," By John A. Ryder, was presented for publication.

AUGUST 23.

Mr. CHARLES MORRIS, in the chair.

Nine persons present.

The deaths of the following were reported:—

Prof. S. F. Baird, a member, Aug. 19, 1887; Nathaniel Archer Randolph M.D., a member, Aug. 21, 1887; Ezra Michener M.D., a correspondent. June 24, 1887 and H. W. Ravenel, a correspondent, June 17, 1887.

AUGUST 30.

Mr. CHARLES MORRIS, in the chair.

Fourteen persons present.

Mr. Harold Wingate was elected a member.

The following was ordered to be printed:—

NOTES ON THE SPECIFIC NAMES OF CERTAIN NORTH AMERICAN FISHES.

BY CARL H. EIGENMANN.

1. In the Proceedings U. S. Nat. Mus. 1885 p. 72. Dr. Jordan says. "The yellow Perch must . . stand apparently as *Perca lutea*. The name *Centropomus luteus* Rafinesque, "Précis des Découvertes Somiologiques, 1814" is apparently prior to that of *Bodianus flavescens* Mitchill 1815.

Prof. Mitchill also described this species in his "Report in Part on the Fishes of New York, p. 18, Jan. 1, 1814, under the name *Morone flavescens*.

This name seems to be still earlier than that of Rafinesque and the species may stand as *Perca flavescens* (Mitchill.)

2. The name *Morone interrupta* Gill seems to be preoccupied by the *Perca mitchilli* var. *interrupta* Mitchill,[1] (Trans Lit. & Phil. Soc. New York, i, 415, 1815), which is also a species belonging to the same genus, *Morone*. As this species has no synonyms it may receive the new name of *Morone mississippiensis* Jordan & Eigenmann nom. sp. nov.

3. In the transactions of the Literary and Philosophical Society New York, i, pp. 457 and 458, 1815, Mitchill gives an account of a small herring under the name of "New York Shadine (*Clupea radina*,)" The description reads:—

"An elegant species with a small smutty spot behind the gill-cover, but with neither spots nor stripes on its back or sides. Mouth wide and toothless. Tongue small.

"Back delicately variegated with green and blue. Lateral line straight, sides silvery white, considerably above that line, and below it quite to the belly. The white reflects vividly green, red or other splendid hues. Head rather elongated. Lower jaw projecting.

"Scales very easily deciduous. Form neat, taper and slender. Gills rise into the throat on each side of the root of the tongue. Eyes pale and large. Tail deeply forked. On account of the even connection of the false ribs the belly is not at all serrated, but quite smooth. A semitransparent space in front of the eyes from side to side. Rays, B. 7; P. 16; V. 9; D. 18; A. 15; C. 19."

[1]That is *Morone lineata* (Bloch). We are unable to separate generically *Morone* from *Roccus* and the name *Morone* has a few lines priority. J. & E.

Leaving out of consideration the first paragraph, this is a fair description of *Etrumeus teres* DeKay. There is no evident spot behind the gill covers in alcoholic specimens and the mouth has teeth. There is a narrow dark bar extending on the sides along the posterior margin of the opercle to its angle. This may be the smutty spot referred to by Mitchill. The teeth are not evident to the naked eye in specimens 3 inches long and may easily have been overlooked by Mitchill.

The specimen described by DeKay under the name of *Alosa sadina* is evidently *Brevoortia tyrannus* and not the species of Mitchill. DeKay fearing that *sadina* would get confounded with *sardina* took the liberty to substitute *notata* for the former. DeKay thinks the description of Mitchill to be insufficient, but the character "the belly is not at all serrated" separates this species from all other New York clupeoides.

The species may stand as *Etrumeus sadina* (Mitchill.)

SEPTEMBER 6.

Mr. CHARLES MORRIS, in the chair.

Sixteen persons present.

SEPTEMBER 13.

Mr. CHARLES MORRIS, in the chair.

Sixteen persons present.

SEPTEMBER 20.

Mr. THOMAS MEEHAN, Vice-President, in the chair.

Eighteen persons present.

SEPTEMBER 27.

Mr. JOHN H. REDFIELD, in the chair.

Eight persons present.

The death of Joseph Patterson, a member, was announced.

The following was ordered to be printed:—

ON THE HISTOLOGY OF SALPA.

BY DR. CHAS. S. DOLLEY.

In connection with a study of budding in *Salpa* by Prof. W. K. Brooks, I have undertaken to review the histology of *Salpa*. Thirty years ago Prof. R. Leuckart[1] in commencing a study of the same animal made the remark; "Seit fünfzig Jahren sind diese Thiere unzählige Male von Zoologen und Anatomen beobachtet worden, and doch ist das Studium derselben immer noch versprechend und lohnend für den Forscher," which is still true: and though it may at first thought seem presumptuous to expect any thing new from an animal which has been repeatedly investigated during the last eighty years, it was deemed best to go over the ground according to the improved methods of modern histological research. The work was mostly done in the Biological Laboratory of Johns Hopkins University, and completed in the autumn of 1884 in the Laboratory of the Zoological Institute in Leipzig.

The specimens used, collected by the United States Fish Commission in Vineyard Sound, were preserved in alcohol, and in chromic or picric acids.

The so-called "*Tunica externa*" or cuticle of *Salpa* is a secretion product of the ectodermal cells of the "*Tunica interna*." It is a hyaline, homogeneous, elastic material, showing at times, especially in young specimens, a faintly laminated appearance. This lamination is absent in the adult forms, where it is destitute of any appearance of structure, the clear field being broken only by minute granules, and occasional small stellate or spindle-shaped cell-like bodies scattered irregularly through it. These latter are, so far as I have been able to observe, destitute of nuclei, and have no connection with one another. They are probably the remains of cells which have wandered from the ectoderm into the newly formed cuticular secretion. Like the outer mantle of *Doliolum* and the "Haus" of *Appendicularia*,[2] it seems probable that this cuticle is from time to time shed and renewed. I assume this from having found in my collection several empty outer mantles, and also numerous specimens in which

[1] Rudolf Leuckart:—"Zoologische Untersuchungen." "Zur Entwickelungsgeschichte der Tunicaten. Salpen und verwandte." Giessen 1854.

[2] Basilius Uljanin:—"Fauna und Flora des Golfes von Neapel." Monographie X. *Doliolum*. p. 14. Herausgegeben von der Zoologischen Station zu Neapel, 1884.

the outer mantle was unusually thin and soft as if newly formed, while the exuviæ were stiff and elastic.

The "*Inner Mantle*" presents an ectodermal and an entodermal cellular layer, which are separated by a hyaline connective basis substance, of varying thickness, in which lie buried the viscera and the muscular bands, and through which a net-work of blood sinuses burrow in all directions.

The ectoderm consists of a single layer, of pavement epithelium, made up of polygonal, usually hexagonal cells (Plate xiii, figs. 1, 2), in which the protoplasm with its oval, often slightly bowed nucleus occupies the central portion; the remainder of the cell appearing empty and transparent, and the boundaries between neighboring cells being very poorly defined. These cells lie directly upon the basis substance of the inner mantle, and are on their outer surface in contact with the cuticle or outer mantle.

I have nowhere in the ectoderm of *Salpa* been able to find such large pavement cells, containing a protoplasmic reticulum extending out from a centre plasma-mass as Uljanin[1] and Grobben[2] described in the larvæ of *Doliolum;* but in several young specimens I find a layer of epithelial cells, lining the cavity containing the elæoblast which present an appearance corresponding in almost every particular to those described by Uljanin. The plasma of these cells is mostly collected into a central mass from which go out processes, anastamosing freely and connecting it with a thin, less granular layer at the periphery. The nuclei are oval in form and sometimes lie to one side of the central mass. Not having living specimens at hand, I was unable to ascertain anything in regard to the granular streaming in the protoplasmic network or the retraction of processes and the extension of others by the central mass as described by Uljanin. These cells lining the elæoblastic cavity are several times larger than the cells of the ectoderm covering the body, but they are similar in structure, and are probably larger because younger, since Uljanin found several undergoing fission. At the two openings of the body, branchial and cloacal, the ectoderm passes over into the entoderm or layer of cells lining the inner mantle; these correspond almost exactly with those of the ectoderm, except that the cells are usually from one third to one half smaller. They vary both in

[1] l. c. p. 13.

[2] C. Grobben:—*Doliolum* und sein Generationswechsel, Arbeiten des zoolog. Institutes zu Wien. Bd. IV, 11 ft. 2.

breadth and thickness in various parts of the body, as do the ectodermal cells. The entodermal cells are raised up into two ciliated bands upon the lateral walls of the branchial chamber and form a hoop-like elevation about its anterior end, which being inclined backward as it passes toward the dorsal surface, connects the anterior ends of the endostyle and the gill.

Between the ectoderm and entoderm is a transparent structureless material of the same appearance as that composing the outer material, but lacking the elasticity of the latter on account of its being pierced and hollowed out by the numerous blood channels and sinuses. Lying embedded in this porous matrix are the *Muscles;* these are composed of from six to twelve broad, flat, striated muscular fibres arranged in bundles, with their broad surfaces in contact and their edges presenting towards the interior and exterior of the body. (figs. 3, 4, 5.) The fibres are made up of several large muscle cells which have become fused together, each fibre showing a large number of oval nuclei, clear, bladder-like, with relatively large nucleoli. The fibres have a longitudinally striated appearance caused by the granular contents being arranged in rows representing the ultimate fibrillæ. The transverse striation is not always to be seen, but there is usually present, especially when the bundles are viewed on the surface, an irregular transverse marking of the entire bundle, due to certain portions of the cells taking a deeper staining. (fig. 5.)

The *Gill* ("hypopharyngeal band" Huxley) is a cylindrical tube in the living animal, but in preserved specimens more or less collapsed. Its walls are a continuation of the entoderm, and it is filled with the same spongy basis material that separates the ectoderm and entoderm, and like this it is perforated by an irregular series of blood sinuses; not by "a single grand sinus" as described by Huxley[1] (fig. 6, 7.). The cells constituting the walls of the gill are in the main, identical with those of the entoderm and remain unchanged along the upper and lower surfaces of the organ, but on the sides they become altered into two longitudinal series of ciliated ribs (*c b*, fig. 6.). These form cushion-like elevations, and are made up of three layers of spindle-shaped cells, the outer layer of which bear rather long stiff cilia.

The cilia-bearing cells are arranged in regular rows upon the cush-

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[1] Huxley, (F. H.):—On the Anatomy of *Salpa* and *Pyrosoma*. Royal Society Transactions, 1851, p. 570.

ion, and the number constituting a transverse row in one of the cushions has been given by Leuckart[1] as from four to twelve; but I find a much wider variation than this in the same and in different individuals (fig. 7.). The number of ciliated ribs or cushions also varies greatly, running from one hundred to two hundred. At the anterior end of the gill two of the upper series of cushions are continued out upon the wall of the branchial sac, and form the semicircular ciliated bands, which run obliquely around the anterior extremity of the endostyle.

The *Endostyle* of *Salpa runcinata-fusiformis* (fig. 8) differs considerably from that which has been so thoroughly described by Fol[2] in various Tunicates, among others *Salpa maxima, S. bicaudata, S. pinnata, S. democratica.* Running along each side of the endostyle on the floor of the branchial cavity are the two ciliated border bands described by Fol (fig. 8, *cbb.*). In some specimens but one of these bands appears to be ciliated, causing a lack of symmetry as was early pointed out by H. Müller and recently by Seeliger. They consist of twelve or more thick cylindrical cells, bearing numerous cilia. These bands are separated from the endostyle proper, by a space of the ordinary pavement epithelium of the branchial sac. The "inner" (Fol) "upper" (Uljanin) glandular cushion is usually in section made up of thirteen or fourteen large columnar glandular cells poorly defined from one another (fig. 8, *igc.*). Those lying deepest in the groove are the longest and thickest, giving the cushion a wedge-shape, the apex forming the upper edge of the endostyle. The cells of this cushion have a granular contents and present in the lower third large bladder-like nuclei with relatively large and striking nucleoli; the upper portion of each cell is coarsely granular, and it is difficult to say where the cell ends and the secreted matter begins. Usually the two cells lying at the lower end of the cushion show a longitudinal striation composed of dark bacillus-like spots. According to Seeliger these cells contain the pigment particles, probably the coarse granules of my preserved specimens, which gives to the endostyle its blue color. There is no "middle intermediary band" present in the endostyle of *Salpa runcinata-fusiformis*, the "inner glandular cushion" resting directly upon the "middle glandular cushion" (*igc.* and *mgc.* fig. 8.). This is also the case with the

[1] l. c. p. 36.

[2] *Fol.* (*Hermann*):—Ueber die Schleimdruse oder den Endostyl der Tunicaten. Morphologisches Jahrbuch. Vol. 1. 1876.

specimens described and figured by Seeliger. The middle glandular cushion consists of eleven long pear-shaped cells, arranged with their large ends towards without, giving a section of the cushion a kidney-shape. The contents of these cells have none of the coarsely granular look of those of the "inner" glandular cushion, but present a faint longitudinal striation; they bear very clear round nuclei in their basal portions, in the centre of which are prominent round nucleoli. Below the "middle" glandular cushion is the so-called "outer intermediary band," (fig. 8, *oib.*) but this is again different from any described by Fol. Instead of consisting of simple pavement cells it is here made up of three layers of spindle-shaped cells with long rod-like nuclei; the inner layer of cells bearing fine short cilia. The "outer intermediary band" as figured by Seeliger, differs from those of Fol and myself in being composed of non-ciliated *columnar* cells. The "outer glandular cushion" (*ogc.* fig. 8) is composed of eleven cells very like those of the "middle" glandular cushion, and arranged after the same manner, pear-shaped with large ends towards without. They present however several nucleoli in each nucleus instead of but one. The two halves of this cushion forming together the floor of the endostyle present their largest curves in an exactly opposite manner to that figured by Fol, but similar to that of Seeliger. The basal portions of the largest cells of the two halves lie together in place of being turned away from one another. In none of my specimens have I been able to find the exceedingly long cilia, nor the two small oval cells described by Fol as bearing them, and as lying between the right and left halves of the "outer glandúlar cushion."

The *Alimentary canal* begins with a trumpet-shaped pharynx (*ph* fig. 9,) the everted edges of which pass over into the entodermal lining of the inner mantel. Its cells are rather long, cylindrical and hyaline, with small clear nuclei in the basal portions; they bear coarse lancet-shaped cilia. The character of the cells remain the same throughout the œsophagus, (*oe* fig. 9) which is considerably contracted in diameter; but upon reaching that portion of the canal which corresponds to the stomach of *Doliolum,* although there is no special dilatation of the canal, they lose their cilia and assume a somewhat more cuboidal character appearing at times to be piled loosely upon one another in several layers. Just here where the ciliated epithelium of the œsophagus changes into that of the stomach, the alimentary canal is joined by two cœcal appendages, one

on each side lapping over the stomach and intestine (fig. 10 *cœ.*). The cells and their arrangement in these cœca are of an entirely different character from those of the œsophagus, stomach or intestine. A transverse section shows a series of very prominent, coarsely granular, pyramidal cells, containing in the lower third a round nucleus and several, usually three, nucleoli. They are separated from one another by lighter, finely granular spaces, which when viewed from the surface of the cœcum (fig. 11.) present a reticulated appearance.

Whether this is due to the presence of small polygonal cells separating and surrounding the large glandular cells, or whether it is a mesh work of threads, formed from the secretion of these cells and connecting them, as in the livers of some molluscs, I can not be positive; I can not, however, detect any nuclei in the cell-like spaces.

Huxley[1] described but one cœcal appendage in *Salpa*, and called it the stomach, into which, according to his description, opened the duct from the net-work of anastamosing tubules which ramify over the visceral nucleus. In the form which I have examined there are present two cœcal appendages (fig. 10) as single sections plainly show and as I have learned positively by a model of the visceral nucleus constructed according to Born's "Platten-Modillir" method.[2] Seeliger in his paper, referred to further on, also mentions and figures but one cœcum. I can only account for the disagreement between the observations of Huxley and Seeliger on the one hand and my own on the other, by the supposition that the number of cœca varies in different species. I shall take advantage of the earliest opportunity, however, to examine the visceral nuclei of all species of Salpæ.

My observation agrees with those recently made by Seeliger in confirming H. Müller's statement that no food is ever found in these cœcal appendages, but their lumen is often filled with a structureless product of secretion. Opening as they do at the anterior end of the stomach they are evidently of some material use in digestion, and from the arrangement and structure of their walls I am of the opinion that they function as hepatic organs, as was first proposed

[1] l. c. p. 571.

[2] Archiv. f. mikroscop. Anat. xxii, p. 584, 1883. Amer. Naturalist, April 1884.

by H. Müller[1] from the peculiar contents of the glandular cells as observed by him.

As set forth at length in a former communication to this Academy[2] I was unable in any of my specimens to find in the œsophagus or stomach of *Salpa* the large plasmodium described by Koratneff.[3] I have serial sections from many specimens showing the entire curve of the alimentary canal from the mouth to the rectum in which the lumen throughout is perfectly free from any organized protoplasmic mass. Other preparations show the food laden mucus passing from the branchial cavity through the pharynx, œsophagus and stomach. Before reaching the stomach, on account of its containing much protoplasmic material which has not yet been acted upon by the digestive juices, this mixture of food and mucus takes staining very well; but after reaching the stomach it gradually refuses to stain, and in the intestine consists of a mass of colorless debris, owing to the organic materials having been removed by digestion. Sections cut diagonally across the œsophagus sometimes appear as though the lumen of the tube was almost obliterated except a narrow slit on one side, this is not actually the case as sections cut longitudinally (fig. 9.) or at right angles prove.

My observations opposed to the presence of an inter-cellular or parenchymatous digestion in *Salpa*, referred to above, have since been confirmed by Oswald Seeliger[4] in his interesting and valuable paper on the budding of *Salpa*, in which he refers to this subject as follows:—"Ich muss demgegenüber nun darauf aufmerksam machen, dass Korotneff im Magen von *Salpa africana* Verhältnisse angetroffen hat, die darauf schliessen lassen, dass in denselben thatsächlich Nahrung hineingelangt und daselbst verdaut oder resorbirt wird. Ich habe leider Koratneff's Angaben über die "freien Magenzellen" und die "parenchymatöse Ernährung" der Tunikaten nicht an verschiedenen Objekten nachstudiren können, bei *Salpa democratica* aber fand ich sie nicht zutreffend. Auch von anderer Seite (Dolley)

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[1] Heinrich Muller, Ueber die anatomische Verschiedenheit der zwei Formen bei den Salpen. Ztschr. f. wiss. Zool., Bd. IV. 1853, p. 330.

[2] "Some observations opposed to the presence of a parenchymatous or intracellular digestion in Salpa." April 15th 1884 vid. Proceedings, Acad. Nat. Sci. Philadelphia. Zool. Anz. 1884, p. 705.

[3] Dr. A. Koratneff. Ueber der Knospung der Anchinia. in Ztschr. f. wiss. Zool. Bd. 40. Hft. 1, 1884, Feb. 19.

[4] Oswald Seeliger. "Die Knospung der Salpen" Jenaische Zeitschr. fur Naturwissenschaft," Bd. 19, page 631.

hat man Korotneff's Auffassung nicht zustimmen können, und es wäre in der That eine nochmalige Nachprüfung von dessen Mittheilungen wünschenswerth, bevor man das eigenthümliche Verhalten der Tunikaten beim physiologischen Processe der Ernährung zu der Schlussfolgerung—der ich aber aus anderen Gründen volkommen beipflichte—verwendet "deswegen haben wir in unserem Falle Ursache, noch an der hohen genetischen Stellung zu zweifeln, die den Tunikaten zugeschrieben ist."

At the beginning of the intestine proper the cells composing the walls resume the appearance of those of the œsophagus and again cilia show themselves.

The presence of cilia for moving on the intestinal contents is necessary on account of the lack of any musculature in connection with the visceral nucleus. There is present under all the cells of this tract a delicate basement membrane in which nuclei may occasionally be seen. Spreading over the visceral nucleus is a net-work of delicate tubes; the "darmumspinnende Drüse" of Seeliger and others.

These consist of an extremely thin basement membrane bearing cuboidal cells of a pale transparent character in which there was no nucleus visible. In no place could I detect cilia in these tubules as described by Chandeleon[1] for *Perophora,* but I did find numerous large concretion-like masses of a dark-brown color. Seeliger believing these glandular tubules to be hepatic in function might perhaps consider the above dark-brown masses as biliary secretion.

The disadvantage of having no living specimens to examine is apparent when I say I can not find the plasma off-shoots from the stomach cells into the lumen of the same, nor the glandular cells, containing yellow drops, seen by Seeliger in the stomach walls of living specimens.

Filling up the cavity produced by the doubling of the intestine, and by the two cœcal appendages, lie the *Testes* which consists of a number of delicate tubes in which a basement membrane is scarcely apparent; and a layer of clear round cells containing pear-shaped nuclei, form the walls. I could not find the "spindle-shaped nucleated cells forming a sort of connective tissue about the gland as described by Leuckart.[2]

The *Heart* lies in a pericardium which appears to be but a sac

[1] Th. Chandeleon :—Recherches sur une annexer du tube digestif des Tuniciers in Bull de l'Acad. Roy. de Belgique. 44me Année. 2e Ser. T. XXXIX, p. 911, 1875.

[2] l. c. p 36.

formed from the entodermal layer of the inner mantle, the cells of both being similar in every respect. The heart itself is composed of a structureless basement membrane supporting a layer of striated fusiform muscle cells. These "fibre cells" lie upon their flat sides, with their long axes at right angles with the long axis of the heart. They have a single oval nucleus and present a delicate transverse striation (fig. 12.). They are much smaller than the fibres of the trunk muscles.

The *Elæoblast* (statoblast of Vogt.) situated on the central side of the body near the cloacal opening consists in hardened specimens of a mass of large irregularly polygonal bodies, showing no nuclei and varying greatly in size. They are opaque and have a coarsely granular appearance as if filled with a sort of yolk material. They are undoubtedly cells which have been greatly engorged and modified. In sections they usually drop out to a large extent owing to the removal of the oil and fat by the reagents, leaving a reticulum made of the transparent connective material of the inner mantel in a cavity of which, or rather on the outer side of which, the elæoblast lies; the entire mass being covered with the peculiar large plaster cells previously described.

The function of this body seems still to be undetermined. In adult specimens it disappears entirely, but is present both in solitary and chain *Salpæ* when young. Vogt held it to be homologous with the placenta, Salensky[1] considers that in those *Salpæ* developed from the egg it arises from the same elements out of which the blood corpuscles and muscles are formed ("amœboid follicular cells"); in the chain *Salpæ* it is developed from the mesoderm.

The *Nerve Ganglion* or brain presents a nearly spherical mass covered with a delicate membrane which seems continuous with the outer sheath of the nerve trunks. Upon section it shows an outer layer of apolar ganglion cells, only the nuclei of which are to be seen as a rule, and a central portion of lighter colored fibrillar ("punct") substance (fig. 13, *NG*.).

Resting upon the brain and in fact a continuation both of the central fibrillar core and the external layer of ganglion cells, is the *Visual Organ* of *Salpa*, (regarded by Huxley as an auditory organ.) Outside of its nervous central portion (fig. 13 *vo*) is a layer of rather large cylinder cells (fig. 13 *pc*.) containing in their inner halves a

[1] Salensky (W.):—"Uber die Entwickelungsgeschichte der Salpen" in Zeitschr. f. wiss. Zool. XXVII 1877. Morphol. Jahrb. III p. 591.

round nucleus and a quantity of dark pigment; the upper and outer halves being clear and transparent. In no case did I find the nuclei in the clear outer portion, as figured by Seeliger (l. c. pl. xi, fig. 13). These pigment cells are in their turn covered with a layer of columnar cells, each of which contains a nucleus in its outer end. This layer does not seem continuous with the entodermal layer covering the brain, and is probably a modified portion of the ectodermal layer of the inner mantel. In one or two specimens which I had prepared without ascertaining their specific name, I found the eye to be much more flattened than in the figure given here, and divided up into several lobes.

From the above description, *Salpa* would seem to possess a sort of compound eye. Passing out from the central fibrillar portion of the brain, are several nerve trunks; from eleven to twenty-five pairs, which show a clear envelope with a dark granular axis. No fibrils are to be seen. The brain is covered by the entoderm which is, however, not in direct contact with it at all points.

Below and anterior to the brain the entoderm of the median dorsal surface is invaginated to form the *Ciliated Sac*, (l'hypophyse.) This structure as seen in other Tunicates has given rise to much discussion in regard to its function. Ussow[1] and Julin[2] regard this as a gland, Joliet[3] considers it to be olfactory in character. In *Salpa* it consists of a simple tube (fig. 13, *l'Hy.*) closed at the end next the ganglion against which it rests, and opening at the other end into the branchial sac. Its walls are made up of short thick columnar cells carrying heavy cilia. It, however, possesses no such peculiarities as the glandular cœca described in *Ascidia mammillata.*

LETTERING OF FIGURES, Pl. XIII.

(*bs*) blood sinus.

(*Br or br*) branchia.

(*cb*) ciliated cushion (in gill).

(*cbb*) ciliated border band.

(*ct*) cuticle.

(*coe*) cœcal appendages.

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[1] Ussow:—"Beitrage zur Kenntniss der Organization des Tunicaten." Moscow, 1876.

[2] Julin (Chas.):—l'Hypophyse des Ascidiens in Bull. Acad Sc. de Belgique, 3d. Ser. T. 1. P. 2, p. 151.

[3] Joliet. M. L.:—"Sur le developpement du ganglion et du "sac cilie" dan le burgeon du Pyrosome" Compte. rend., Ac. Sci. Paris. T. 94, No. 14, p. 988.

(*ec*) ectoderm.
(*en*) entoderm.
(*Hm*) heart muscle.
(*igc*) inner glandular cushion.
(*im*) inner mantle.
(*int*) intestine.
(*l'Hy*) l'hypophyse.
(*m. b.*) muscular bands.
(*mf*) muscles fibres.
(*mgc*) middle glandular cushion.
(*mib*) middle intermediary band.
(*nf*) nerve fibre.
(*ng*) nerve ganglion.
(*oe*) œsophagus.
(*ogc*) outer glandular cushion.
(*oib*) outer intermediary band.
(*pc*) pigment cells.
(*ph*) pharynx.
(*vo*) visual organ.

EXPLANATION OF FIGURES, Pl. XIII.

Fig. 1. Section of inner and outer mantles.
" 2. Surface view of ectoderm.
" 3. Portions of three muscle fibres from muscular bundle.
" 4. Section through one of the muscular bundles of the trunk showing its position in the inner mantle.
" 5. Seven muscle fibres as seen from a surface view of one of the bundles.
" 6. Transverse section of the entire gill.
" 7. Longitudinal section through a portion of the gill, on the plane of *cb*. in fig. 6.
" 8. Showing one half of a transverse section of the endostyle
" 9. Longitudinal section through the œsophagus.
" 10. Transverse section of the intestine and the two cœcal appendages.
" 11. View of the outer surface of a cœcal appendage.
" 12. Striated muscular "fibre cells" composing the wall of the heart.
" 13. Vertical section through brain, visual organ, and l'hypophyse.

OCTOBER 4.

The President, Dr. JOSEPH LEIDY, in the chair.

Seventeen persons present,

A paper entitled "The Classification of the Post-Cretaceous Deposits." By Angelo Heilprin, was presented for publication.

OCTOBER 11.

The President, Dr. JOS. LEIDY, in the chair.

Twenty-two persons present.

A paper entitled "Prolonged Life of Invertebrates. Notes on the Age and Habits of the American Tarantula." By Henry C. McCook, D. D. was presented for publication.

At the meeting of the Botanical Section held September 12th, a paper entitled "Contributions to the Life-Histories of Plants." By Thomas Meehan, was recommended for publication.

Fossil bones from Florida:—Prof. LEIDY stated that he had recently received for examination, from the Geological Survey in Washington, two barrels and three boxes of fossil bones from Florida. They are labelled as having been collected by L. C. Johnson, from Mixson's bone-bed, 10 miles east of Archer, Levy Co., Florida. A note accompanying the collection, states that trenches were cut in the bed to the bottom rock from two and a half to six feet deep, and that the bones were found distributed abundantly without order, through the clay from top to bottom. The bones especially the larger ones, are generally much broken, though the original texture is mostly preserved, and they exhibit no trace of being rolled or water worn. The fractures appear to be entirely accidental or with no evidence of human action. Some portions of clay in large hollows of several specimens exhibit finely comminuted bones. The fossils pertain to the same animals previously indicated from the same locality in former communications (See the Proceedings, 1884, 118; 1885, 32; 1886, 11, 37.) They consist chiefly of the remains of *Rhinoceros proterus*, *Mastodon floridanus*, and *Auchenia major*. Among them are a number of well preserved molars of the Rhinoceros and Mastodon. Several more characteristic specimens prove that he had formerly committed a blunder in referring the fragment of a tooth, to an extinct boar with the name of *Eusyodon maximus* (Proc. 1886, 37), which is only part of the lower tusk of the rhinoceros. A tooth from the same locality, sent him by Dr. J. C. Neal of Archer, Florida, indicates a species

of *Hippotherium* different from *H ingenuum* (Proc. 1885, 33), and also seems sufficiently distinct from the corresponding tooth of the many other species of the genus elsewhere found in America, to render it probable it pertains to an undescribed species. It is an upper molar of an animal approximating the Ass in size, and larger than *H. ingenuum.* The triturating surface, represented in the accompanying figure, exhibits a complexly folded condition of the enamel, quite different from that of the latter,(compare figure in Proc. 1885, 33). The species may be named *Hippotherium plicatile.* Three lower molar teeth according in size with the upper one were also received from Dr. Neal. An astragalus and fragments of several other bones contained in the former collection accord in size with the teeth of *H. plicatile,* while an astragalus received from Dr. Neal accords in size with the tooth of *H. ingenuum.*

1½

Comparative and other measurements are as follows:—

	H. plicatile.	*H. ingenuum.*
Upper molar, triturating surface:		
Breadth fore and aft	20*mm*	19*mm.*
Breadth transversely	23 "	17 "
First lower molar:		
Breadth fore and aft	25*mm*	
Breadth transversely	14 "	
Intermediate lower molar:		
Breadth fore and aft	22*mm*	
Breadth transversely	12 "	
Astragalus:		
Breadth fore and aft	49*mm*	35*mm*
Breadth transversely behind .	40 "	29 "

OCTOBER 18.

Mr. JOHN H. REDFIELD, in the chair.

Nineteen persons present.

OCTOBER 25.

The President, Dr. JOS. LEIDY, in the chair.

Twenty-four persons present.

Preliminary note on a new mineral Species from Franklin, N. J.—Prof. GEO. A. KOENIG called attention to his recent examination of a mineral from the above locality which has not been heretofore

known. This mineral occurs in pale grayish yellow, stellate masses, somewhat resembling karpholite or pyrophyllite. It is associated with calcite. The stellate aggregation is readily friable as it breaks into minute prismatic particles. Made into an artificial splinter, the substance fuses in the oxydizing flame to a black glass. Heated in a closed tube it yields abundant water at a red heat, changing its color to chocolate brown. The water does not act acid, nor corrode glass. Carefully dissolved in a borax bead, the latter remains colorless at first, then gradually assumes the characteristic manganese color. The powder dissolves in hot concentrated hydrochloric acid but does not gelatinize. The specific gravity (determined with 1.4230 gram.) is 2.981.

The analysis gave

$$\begin{aligned} SiO^2 &= 39{\cdot}00 \\ MnO &= 42{\cdot}12 \\ H^2O &= 8{\cdot}44 \\ FeO &= 3{\cdot}75 \\ ZnO &= 2{\cdot}86 \\ MgO &= 3{\cdot}83 \\ \hline & 100{\cdot}00 \end{aligned}$$

The determination of iron was lost, its quantity is made up by the difference. Manganese is present as MnO; (the peculiar behavior in borax mentioned above, and the absence of any evolution of chlorine, when dissolved in HCl are proofs of this assertion.) Calcium is only present in traces and was weighed with the magnesia.

If we calculate the molecular ratio of the oxyds we obtain (MnO, H^2O, FeO, ZnO, MgO) : SiO^2 = 1 : 231 : 0·65 = 1·89 : 1 = 2 : 1.

This is the ratio of an orthosilicate, and in fact is the molecule of Tephroite, in which a considerable portion of manganese is replaced by water. That the water must be considered as basic, follows from the fact that none is expelled at 200° C. The low specific gravity is very extraordinary and seems to indicate a polymeric condition of the molecule. The name *Bementite* is proposed for this species.

Remarks on Hydra:—PROF. LEIDY remarked that in our fresh waters there occur two well marked species of hydra, the one of a bright green color, the other pale brownish or reddish. He continued, these, judging from descriptions and figures, appear to him to be the same as the European species *H. viridis* and *H. fusca.* The late Prof. L. Agassiz regarded them as different and named them *H. gracilis* and *H. carnea* (Proc. Bos. Soc. Nat. Hist. 1850, 354.) Familiar as he was with both the European and American animals his opinion might be considered conclusive, but the only distinctive character he assigns to each seems not to be correct. Of our green hydra he observes that unlike the European it has the power of extending its body in a remarkable degree. Opposed to this view,

Rösel in 1755, represents *H. viridis* in the same condition and with the arms in the same proportionately short state (Insecten Belustigung, Theil 3, Tab. 88, Fig. 4.) In other characters, the speaker found our green Hydra to accord with *H. viridis*; and further in respect to the sexual organs. Prof. Allen Thompson describes the latter as producing a single ovary near the middle of the body and two or three spermaries from the body just below the arms (Edinburgh Philos. Jour. 1847, 281.) The same condition he had observed in our green hydra, as represented in the drawings exhibited. As regards our brown hydra, Agassiz gives as the distinctive character, that it has very short arms while the European has long ones. Ordinarily this appears to be the case, but on several occasions the speaker had observed our brown hydra, after it had been kept some time in an aquarium where there was comparatively little food, elongate its arms, extremely attenuated, even to a length of three inches. In this condition it closely resembled in appearance the beautiful figure of *H. fusca* in figure 1, plate 64. of the Regne Animal of Cuvier.

He had the opportunity of seeing both the green and brown hydra west of the Rocky Mts. and these he found to accord in character with our eastern forms. In specimens collected in a lake in the Uinta Mts., Wyoming T., at 10.000 feet elevation, the brown hydra at first was brick red with a brighter red head, but after keeping it for a week, it assumed the pale brown hue as ordinarily observed in the animal nearer home.

The characters of the two American forms as observed by him are as follows:—

Hydra viridis? The green hydra. Animal bright grass green sometimes paler. Body when moderately elongated cylindro-conical, tapering towards the caudal end; when contracted oval or spheroid, when greatly extended linear cylindrical. Head conical. Arms four to seven, commonly six, about half the length of the body, linear, capable of extension to about the length of the body or slightly more. In the sexually mature state:—testes hemispherical surmounted by a nipple-shaped prominence, situated on the sides of the body just below the arms; ovary single, projecting from near the middle of the body and containing a single, spherical, white egg, enclosed in a brownish covering. Animal usually three or four lines long, capable of extension to twice the length or contracting to less than a line. In ponds and ditches in the vicinity of Philadelphia and other places, though not common. Observed on one occasion in the sexually mature condition late in autumn. In the individuals observed the sexes were separate; the males with the two testes, and the females with a single ovary. The ovum measured 0·375mm in diameter. In the sexually mature *H. viridis* observed by Prof. A. Thompson, individuals were hemaphrodite while in others the sexes were separate.

Hydra fusca? The brown hydra. Animal more robust than the former, of the same shape and number of arms, but with the body less attenuated when extended and with the arms habitually longer in proportion to the body, but capable of extension to six times the length of the latter. Color usually pale brownish or reddish; sometimes deeper, sometimes paler. In ponds and common on the under side of stones in the Schuylkill and Delaware Rivers, in the vicinity of Philadelphia. Not observed in the sexually mature condition. The color of the animal in a measure appears to depend on the nature of the food; and it may become a bright red, of variable tint, by feeding on similar colored entomostraca or insect larvæ (See Proc. 1880, 156.) From prolonged abstinence the color fades and the animal becomes almost white.

Craig D. Ritchie was elected a member.

The following were ordered to be published:—

THE CLASSIFICATION OF THE POST-CRETACEOUS DEPOSITS.*

BY PROF. ANGELO HEILPRIN.

The point of first importance to determine is whether all the deposits succeeding the Cretaceous period belong to a single major system, or, as is generally recognized, to two distinct systems, the Tertiary and Quaternary of geologists. It will probably be conceded by all geologists that the only rational scheme of chronological classification is that which can be made to be of universal application; in other words, a system that applies equally to all countries. In our present knowledge, but one such scheme of broad classification is known—that which is based upon the rise and fall of successive faunas. Granting a nearly equivalent development of life-forms for the greater portion, if not the whole, of the earth's surface—a condition which can now be satisfactorily demonstrated, or at least demonstrated to a variation within narrow limits—it will be manifest that we have in this development a true guage of chronological relationship, and one that must be fairly exact in its application. The grouping of systems will then be a mere deduction from the time-record made to correspond to certain well-defined or rounded-off periods, so to speak, of faunal development, whose existence is made known to us through the dissimilarities of successive faunas.

How much, or what amount of, dissimilarity is considered sufficient to mark out distinct systems is a matter of little consequence to the geologist, but where uniformity of classification is required, naturally only equivalent terms, or terms of approximately equal value, should be used. The greater number of the major geological systems now recognized are delimited by faunal dissimilitudes of a more or less definite measure, which is indicated in the ratio of transgressional forms uniting to the system below and to that above. The present classification admits in a general way for each system a faunal peculiarity measured in its lowest terms by some 35 or 40 per cent, and this classification has fairly met the demands of geologists in its application to almost all the entire series of sedimentary rock deposits. Remarkably enough, in the case of the post-Cretaceous deposits, whose classification has been effected probably by greater niceties of percentage divisions than that of any other series, this meas-

* Amplification of a report prepared, by request, for the American Committee of the International Congress of Geologists.

ure has been only loosely, or not at all, adhered to. What, it might be asked, are the claims of the Post-Pliocene and recent formations to being considered a distinct system? Viewed in its faunal aspects, the question may be very readily disposed of: the formations in question have no claim to such recognition. If the formations from the Eocene to the Pliocene inclusive are justly considered to constitute, by virtue of their faunal unity, a distinct system, the Tertiary, then manifestly the post-Tertiary (Post-Pliocene to recent) must be a part of the same system, since its faunal ties unite it infinitely more closely with the more recent members of the Tertiary than the individual members of the latter are united among themselves. Thus the Eocene or Oligocene is further removed faunally from the Miocene than the Pleistocene is from the Pliocene; and the same relation holds with the Miocene and Pliocene. Lyell, himself the framer of the now very generally accepted classification of the post-Cretaceous deposits, admits that in the so-called Newer Pliocene deposits of Sicily the percentage of recent molluscan forms rises as high as 90, or even higher, consequently reducing the faunal peculiarity to less than 10 per cent. In the Chillesford beds of Suffolk, England, the faunal peculiarity is reduced to about 15 per cent, and in the Norwich or Fluvio-Marine Crag to 16 per cent. Again, the uppermost of the Subapennine deposits of Northern Italy, forming part of the "Astian" series (Pliocene proper of Capellini), have been shown by Foresti to hold about 80 per cent of living forms, reducing, therefore, the faunal peculiarity, in its lowest expression, to 20 per cent. On the other hand, the deposits immediately underlying these, forming still a part of the true Pliocene series—Foresti's horizon III—hold barely more than 43 per cent of living forms, and are thus strongly individualized by their faunal peculiarity, in so far, at least, as a relationship with the overlying deposits is concerned, although the ties with the deposits underlying (Mio–Pliocene of Capellini–Messinian of Mayer) are much more intimate. Horizon II of Foresti is characterized by some 39 per cent of living forms, and I by nearly 31 per cent; both of these divisions are by many Italian geologists classed with the Miocene, which really appears to be their true position, contrary stratigraphical evidence notwithstanding.

Seeing how very closely the Pliocene fauna in its highest expression approximates the fauna of the present day (*et conseq.* the Post–Pliocene fauna), and the broad latitude of peculiarity allowed it by most geologists, it becomes interesting to inquire in how far similar

conditions of relationship or divergence obtain among the older Tertiary deposits. It is well known to geologists that in most regions where Tertiary deposits are developed, the faunal relationship existing between the Eocene and Miocene series is a very restricted one; indeed, in some regions it would appear that there is scarcely a single species of fossil held in common by the two classes of deposits. This is very largely the case in France, and perhaps more particularly in the Eastern United States, where the respective faunas are practically wholly distinct. It is true that, in some regions, a careful analysis of the formations now frequently referred to the Oligocene has shown a number of connecting forms, and has brought the two formations in closer relationship with each other, but the uniting bond, as compared with that which unites the Pliocene with the Post-Pliocene, or the Tertiary with the post-Tertiary, is still very weak. In the Oligocene (Vicksburg) deposits of the United States, for example, it is doubtful if the number of transgressional forms uniting with the Miocene numbers more than six, and possibly not that many, out of a total of some 150 species.

These facts being admitted, it can scarcely be argued further that, with our existing classification as a basis, there remains any valid reason for separating, as a distinct system, the Post-Pliocene (post-Tertiary) series from the Tertiary (Pliocene). It may, however, still be contended that we allow too much latitude to the Pliocene, and that with a proper restriction to boundaries in which the recent faunal element does not exceed 70 or 75 per cent, instead of rising to 85 and 90, or more, room may be had for a major series with a largely peculiarized fauna. But even with this limitation the faunal break separating a post-Tertiary series from the upper member of the Tertiary (Pliocene), would scarcely be as great, and in most cases not nearly so great, as that separating the Pliocene from the Miocene, or the Miocene (or Oligocene) from the Eocene.

Apart from the matter of mere numbers as indicating a lack of of peculiarity in the post-Tertiary fauna, it may be urged that there are yet certain elements in it which serve broadly to distinguish it from the faunas immediately preceding, and which would entitle it to the claim of a true system-fauna. Thus, as has frequently been claimed, we have here the first evidences of man, and, therefore, the expression of a so-called "Psychozoic" era; the remains of a remarkable series of large edentate animals—*Megatherium, Mylodon, Megalonyx, Glyptodon, etc.*—foreign to the earlier faunas, yet

sufficiently abundant as a distinguishing element in the fauna of later date; and finally, the elimination of certain faunal features of the period preceding, which can be passed over without further notice. As far as the occurrence of the giant Edentata and of certain other associated animal forms—*Toxodon, Macrauchenia*—is concerned, it may be remarked that by many geologists and paleontologists the beds containing their remains are referred to the Pliocene, and not to the Post–Pliocene, period; and we have now the unmistakable evidence of somewhat similar, or at least related, forms being found in the Miocene and Pliocene deposits of the Western United States. Nor, even if we admit that these remarkable forms are exclusively Post–Pliocene, can it be assumed that they are in themselves sufficient to distinguish a fauna, the less so as their remains have only been found in a comparatively limited portion of the earth's surface, and have yielded no substitutes elsewhere.

The case of man's appearance is equally inadmissible as a factor in the question, since, in the first place, it is now practically certain, even if positive proof in this direction is still wanting, that he already existed during the close of the Tertiary period, and not improbably even at a much earlier date. Furthermore, his advent, looked at purely from the zoological stand-point, could be no more a distinguishing feature in a fauna than would be the advent of *Dryopithecus* or *Hippopotamus*. Nothing can be more illogical than the assumption that because man is of all importance in the faunal element of to-day, judged from the stand-point of our own capricious opinions, he is of equal importance when measured by the purely zoological standard. Equally illogical is the assumption of a Psychozoic age as distinguished from any of the ages preceding.

Having, as I believe, satisfactorily shown that the Post-Pliocene series of deposits, which include the "Pleistocene," "Glacial" and "Recent" of most geologists, cannot be separated as a distinct system from the Tertiary, it becomes necessary to find a common name under which all these series of deposits can be included. The term Kainozoic (Cenozoic) or Tertiary, corresponding to Mesozoic or Secondary, and Palæozoic or Primary, might be conveniently retained, and its application so enlarged as to embrace both the Tertiary and Quaternary in use at present—Quaternary, of necessity, completely dropping away.

It now remains to determine of what relative values are the major

divisions of the Kainozoic or Tertiary. It will probably be admitted by most geologists that the divisions pre-Glacial (Pleistocene), Glacial, and Recent are merely sub-groups of a single major formation, for which the familiar term Post-Pliocene might be conveniently retained. Its value may be accepted as being approximately equivalent to Pliocene, Miocene, Oligocene, or Eocene, although the values of these last differ somewhat among themselves. Indeed, it is not a little difficult to determine what precise significance is to be attached to these divisions of the Tertiary, whether they are of equivalent value with the (generally so considered) corresponding terms of the Mesozoic—Cretaceous, Jurassic, etc.—and Paleozoic series—Carboniferous, Devonian, etc—or not. In most geological tables they are accorded this value, but it is more than doubtful if they are entitled to it. Probably but few geologists will deny that the Post-Pliocene and Pliocene are much more intimately related to one another than are the Devonian and Silurian, the Devonian and Carboniferous, or the Jurassic and Cretaceous. And a similar intimate relation holds by comparison between the Eocene and Oligocene. The Post-Pliocene and Pliocene, again, appear in most cases to enjoy a much closer affiliation than exists between the latter and the Miocene, and similarly, the bond of union uniting the Eocene with the Oligocene is greater than that which holds the latter to the Miocene. So that while it may be impossible to attach absolute values to the terms or periods marked off in Tertiary chronology, it appears to the present writer more in consonance with existing facts, and as a stricter parallel to the methods employed in pre-Tertiary terminology, to group the entire series into three main sections, corresponding to as many periods of geological time, as follows:

KAINOZOIC or TERTIARY	NEOGENE	Post-Pliocene.
		Pliocene.
	METAGENE—Miocene.	
	EOGENE	Oligocene.
		Eocene.

The classification of the Tertiary deposits, brought *en rapport* with the classification of the pre-Tertiary series, and as based upon the formations of the Atlantic slope of the United States, would then be as follows:

Kainozoic or Tertiary	Neogene.	Post-Pliocene	Recent. Glacial. Pleistocene.
		Pliocene.	Floridian.
	Metagene.	Miocene.	Carolinian Virginian. Marylandian.
	Eogene.	Oligocene.	Orbitoitic (Vicksburg)
		Eocene.	Jacksonian. Claibornian. Buhrstone. Eo-Lignitic.
Mesozoic or Secondary.	Cretaceous.	Chalk. (European.) Gault.	Danian. Senonian. Turonian. Cenomanian. Albian. Neocomian.
	Jurassic.	Oolite.	&c.
		Lias.	&c.
	Triassic.		&c.

On the value of the faunal element in geological chronology. Some geologists, and notably those who profess but little knowledge of paleontology, have attempted to make light of the evidence which the zoological record brings to bear upon the classification of rock-masses. Indeed, even at the present time, in some of our surveys only a left-handed assistance is asked by the geologist-in-charge from the paleontologist, with the result known to all who are capable of distinguishing between work that is done and that which still requires to be done. It is true that in many tracts, and in tracts even of wide area, the relative sequence of rock formations can frequently be traced without the aid of paleontology, and a map, more or less perfect, constructed on the details thus brought together. But sooner or later, if the comparative study of a region is necessitated, reference must be had to the fossil remains, which alone serve

to the geologist the data of an infallible chronology. The absolute succession of equivalent faunas, or faunas of a practically identical facies, which has been demonstrated for the greater part of the world, clearly establishes the claims of the faunal element as the *guide propre* in the determination of chronology. It not only serves to fix the relative sequence of formations for any one country, but determines absolutely the position in time which these formations occupy in a geological scale constructed for the entire world.

It is, however, contended, and apparently with force, that certain physical phenomena associated with the disposition of rock-masses are as clearly consecutive in their occurrence as is the progression of the life series, and might, hence, claim equal importance as chronological determinants of the geological scale. Thus, it is pointed out, we have the world over a physical break of definite importance between the Paleozoic and Mesozoic series of rocks, and a somewhat similar break—wanting in some parts—between the Mesozoic and Kainozoic; and, again, minor breaks between the lesser formations. But how could the equivalence of these breaks be determined were it not for the predetermination of age through the faunal remains? It might be assumed, where a deposit of a definite or special lithological character can be continuously followed, such as coal or the chalk of the Cretaceous period, that we are furnished with certain distinctive data which here preclude the possibility of mistaking the actual equivalence; that, for example, where we recognize the break following the chalk in England we recognize a similar break in France and Belgium, and likewise the same for the coal. But by what method, other than the paleontological one, could the post-Cretaceous break be identified or correlated in regions, such as the Eastern United States, where the true chalk is wanting, and where the beds representing it could, from lithological character, about as well be taken to represent an older member of the series to which they belong as a newer one?

The notion held by some geologists that the true determinants of a formation—or, more properly speaking, the true measure of geological time, is found rather in the lithological than in the paleontological record, can not for a moment stand the test of a logical inquiry. To submit, for example, that the matter of continuous sedimentation, or the absence or presence of conformability, or the existence or non-existence of a physical (lithological) break, can in any way affect a time-record based upon the uninterrupted succession

of progressive faunas, requires for its acceptance facts of a very different character from any that geology has thus far brought forward. It is true that geologists may have erred in locating or defining their time-periods (or formations), and, doubtless, more accurate research will alter, or completely obliterate, much that has been done in the way of chronological classification, but to maintain, as some geologists would lead us to believe, that the Cretaceous and Tertiary formations (or periods) no longer exist as such by virtue of the discovery of a series of intermediate connecting beds; or that, for a somewhat similar reason, the Oligocene formation has given up its right to existence independently of the Eocene, is maintaining a position which no geologist who has examined into the premises will be willing to concede. We may as well admit that the various periods recognized in human history do not exist because they can be continuously traced without break of any kind; and similarly, centuries and years have no existence because they are continuously consecutive. The geologist should bear in mind that the time-periods (*et conseq.* the corresponding formations) are artificial constructions based upon equivalent phenomena for the entire world, and serve only for the purpose of a universal classification. The finding of an intermediate formation (period) in no way obliterates the formations between which it may have been found, provided the limits of these formations have been satisfactorily determined; for example, the discovery of a connecting series of deposits between the true Cretaceous and Tertiary, uniting them by way of continuous sedimentation, does *not* render the entire series Cretaceo-Tertiary, but the connecting beds are *alone* entitled to this designation. The Cretaceous and Tertiary sections of the series remain as truly Cretaceous and Tertiary in a general scheme of classification as they were before the intermediate beds were discovered. Manifestly, in a complete geological scale, whose near realization is by no means impossible, all the various formations now recognized will be found united to one another through the intermedium of connecting beds, but certainly no geologist will go so far as to urge that, for this reason, a classification of time, based upon some artificial basis of chronology, will no longer be necessary or desirable.

It has also recently been objected that a classification based upon percentages of survivals is an absurdity, and wholly illogical. Why illogical, it might be asked? Surely, if there has been a general, and nearly equivalent, faunal succession or development for the

world at large—a condition which can be clearly demonstrated—then, manifestly, the ratio of survivals must be a definite measure of this development; and if this is the case, it must, necessarily, prove the safest guide in the delimitation of chronological boundaries. Were it possible to definitely determine the proportion of survivals, or what is practically equivalent to the same thing, determine the amount of actual faunal peculiarities, by specific determinations made with equal care for all countries, we would then have, and only then, a rational basis for a systematic classification applicable to the whole world.

CONTRIBUTIONS TO THE LIFE-HISTORIES OF PLANTS.

BY THOMAS MEEHAN.

Amphicarpæa monoica.—" Flowers of two kinds—those of the upper many-flowered racemes perfect and petaliferous, but seldom maturing fruit, those near the base of the stem on prostrate branches imperfect, but usually fertile." Thus writes Torrey and Gray, and this I think is usual experience. Mr. Darwin, says in "Forms of Flowers" "In three of the genera (*Leguminosæ* known to produce cleistogamic flowers) namely *Vicia, Amphicarpæa,* and *Voandesia,* the cleistogamic flowers are produced on subterranean stems. The perfect flowers of *Voandesia,* which is a cultivated plant, are never said to produce fruit, but we should remember how often fertility is affected by cultivation." (Chap. VIII, p. 327) "Although cleistogamic flowers never fail to yield a large number of seeds, yet the plants bearing them usually produce perfect flowers, either simultaneously or more commonly at a different period, and these are adapted for or admit of cross-fertilization" (ibid p. 340).

I had often gathered the seeds, near the ground on plants growing in shaded woods and thickets, and supposed I was familiar with it. In December of 1886, walking along the banks of the Wingohoccing creek, which runs through my farm, I noted quantities of dry legumes on dead vines that had profusely covered masses of blackberry bushes. I could have gathered pounds of seed. I had never seen *Amphicarpæa* in this condition, and was so completely off my guard, that I was amazed, on a package being returned from Prof. Asa Gray marked "*Amphicarpæa monoica.*" I decided to watch the behavior of the plants more closely another year.

I now find the petaliferous flowers on these plants abundantly fruitful. In what may be termed the more vigorous racemes, the two lowermost flowers either have no petals, or have but a small vexilla projecting a little beyond the calyx. The next half dozen flowers, are perfect in every respect, and are fertile. The succeed-

ing flowers usually fall without perfecting a legume. It may be noted that the legumes and calyx are different in these two instances, Fig. 1, shows the petaliferous and Fig. 2 the apetalous, forms. Thus we have three forms of legumes on the one plant, the hypogeous, which is short, thick and roundish at the end, Fig. 4, and these two now described.

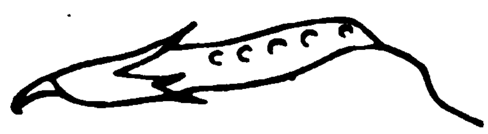

Fig. 1.

Fig. 2.

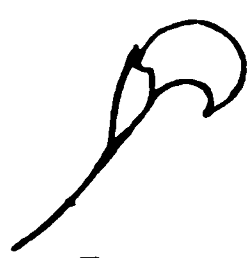

Fig. 4.

The apetalous flowers can be scarcely classed as cleistogene, for there is certainly no pollen in many of them. In the few score I examined at this time, a few undeveloped stamens could be detected here and there. In the absence of positive demonstration, I should rather regard these as pistillate flowers, receiving their pollen from the petaliferous ones.

I do not find the flowers are adapted to cross-fertilization, except in the monœcious manner indicated. In the petaliferous cases the flowers are diadelphous—one stamen being wholly distinct from the rest. These are thoroughly united into a tube for very nearly their full length, little more than the connective of the anthers being free. The pistil, running up this tube, is about the exact length, and the stigma is imbedded in the thick mass of stamens, and completely covered by own-pollen. It is evident that no foreign pollen can possibly reach the stigma. So tightly held together is the mass of filaments, that when the fertilized pistil commences to expand, the ovarium bursts out at the base of the column, and as it grows, draws down through the staminate column, the style, this giving the stigma another full dose of its own-pollen. (Fig. 3.) It is a remarkable adaptation for self fertilization. Besides this close covering of the stigma by the stamens and column, the keel embraces the stamens so closely that even the "tickling" of the flower with a pin, simulating the action of an insect, fails to set them free. As soon as the ovarium begins to grow, and the flowering stage has reached the period illustrated in Fig. 3, the petals fall apart, and the pollen is liberated for the wind to carry it elsewhere.

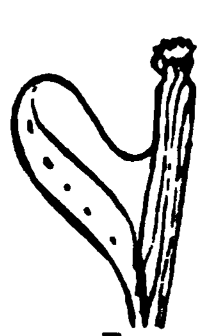

Fig. 3.

Persistent watching failed to note any insects at work, but numerous blossoms of *Impatiens fulva*, possibly afforded the greater attrac-

tions at the time of my observations. The bruised petals of *Amphicarpœa,* showed that, at some time during the day or night, insects were at work on the flowers.

The large vigorous blossoms on these plants were of a brilliant purple. The plants which I have seen with whitish-yellow flowers, in other localities, grow weaker than these. They also produce legumes from apetalous flowers on the climbing stems, but the locality is not near enough for me to watch, to see whether the petaliferous flowers bear freely or not.

Fruiting as these flowers do, on the climbing branches, at least, there are two-thirds fall without seeding. This cannot be from impotency of the pollen, or none would seed. Few leguminose plants, even when exposed to cross-fertilization, perfect more than a small portion of their flowers. Failure is from too great a draft on the nutritive powers of the plant. So many flowers cannot be properly fed, though properly fertilized by pollen. The remarks of Mr. Darwin on *Voandesia,* are no doubt just, changing the word cultivation so as to read "we should remember how often fertility is affected by circumstances."

I have already placed on record that the petaliferous flowers of *Viola cucullata* rarely produce seed under ordinary circumstances, but freely do so when the plant is growing on a dry rockery.

The points I regard as rendered certain by these observations are:

1. That the climbing stems, as well as the trailing ones, of *Amphicarpœa* bear apetalous flowers freely.
2. That these flowers produce a third form of legume.
3. That the petaliferous flowers, under circumstances favorable to nutrition, bear legumes as freely as leguminous plants generally.
4. That the petaliferous flowers are adapted solely to self-fertilization, and I think the probability is developed:

That the apetalous flowers are often fertilized by pollen from the petaliferous ones; and, so far the plant is arranged for as much cross-fertilization as other monœcious plants receive.

A contribution to the life history of Cephalanthus occidentalis.— The pistils of *Cephalanthus occidentalis* are exserted more than an inch beyond the flowers, and as there are usually from one hundred to three hundred flowers in the button-like head, the mass has a well known trichodic appearance. I had never been able to see these extending themselves. The flowers were always either closed or fully expanded with the pistils to their full length. Satisfied that the opening took place during the night, I cut a few on the evening of

Aug. 1st. and placed them in a glass of water in my library, and watched their behavior.

The unopened flower, at 7 P. M., is very interesting from a small tooth bearing a black gland, seemingly situated in the axis between the lobes. It is really on the left hand side of each lobe, and gives to each division when carefully separated the outline of a mitten, where in covering the hand the thumb only is free. At 8 P. M. the lobes have parted, and what one would take to be a pair of united sagittate anthers, covered with pollen, have advanced just their length above the corolla-lobes. At 8·5, this length is doubled. The same progression continued till 8·30 when growth ceased, the slender "filament" having grown six lines in thirty minutes.

Examining next the four anthers in the open flower, they were found apparently destitute of pollen, and, remembering that systematists had found a close relationship between *Rubiaceæ* and *Compositæ*, the idea suggested itself that the stamens in the corolla were sterile, and that in some unaccountable manner two stamens had become as entirely consolidated with the style as in *Orchideæ*, and that only two fertile anthers were left, which had united and formed a cap wholly covering the stigma. Acting on the suggestion a pair of fine tweezers were placed under the seeming anthers, and a gentle lift took it off, as if it were a thimble in miniature, leaving a clear greyish-white ovate stigma behind. The sagittate form of an anther is so plain, and the four angles that these would make united back to back so apparent, that I am satisfied no one, at first thought, would take them for anything else than as described. Full of enthusiasm over the mystery I sent some to my friend Mr. Sereno Watson, to learn what he would think of the "missing link" in this pair of monodelphous anthers. His reply that he found some grains of pollen in the true anther sacs, and only pollen on the stigma, led me to look into the matter again, and I found he was right. The four anthers mature before the pistil takes its rapid start. At anthesis the anthers are pressed firmly over the stigma. When the growth of the pistil occurs, the stigma wipes out, almost clean, the entire mass of pollen, and so nicely as to retain the form of the anther lobes on the stigma as the style develops. I have since found that this simulation of the form of real anthers is not seen in the open air. The motion of the atmosphere or possibly the jar from the visits of nocturnal insects gives a rounded form to the stigma-covering mass.

After twenty four hours, a portion of the clear stigma is seen above the mass of pollen, showing that the stigma expanded a little after the growth of the style had been completed.

I think it is conceded that plants have not a time for the opening of flowers from which they never depart, and that exceptions have been noted in even very regular habits. But it may be stated in a general way that the flowers of this *Cephalanthus* open rapidly, soon after dark, and never during the day time.

The odor of the flowers is singularly grateful. They are visited by large numbers of insects for their nectar day and night. No pollen gatherers seem to work on them. There is indeed no chance to collect it from the stigma, no platform affords a facility for standing during collection. The pollen remains on the stigma till the whole dries away. It is one of the most complete adaptations for self-fertilization known to me outside of the Cleistogene class.

Interested in noting how this absolute in-and-in breeding affected productiveness, I subsequently found the flowers remarkably fertile. Numerous seeds were in every head examined. Carefully dissecting one, I found it had 279 flowers, of these 225 perfected seeds, and only 54 failed.

In describing *Cephalanthus occidentalis* in *Flora Cestrica*, Darlington describes the flowers as "five lobed;" most other botanists "four-parted." My flowers were mostly four, but many five-parted.

The glands between the lobes of the corolla appear to have been unnoticed. That the receptacle is "filiferoüs" has long been observed (Loureir's Flora of Cochin China, 1788), and Gray (Synoptical Flora of North America 1884) notes that these "setiform bractlets" between the flowers are glandular-capitate. Donn (Dichlamydeous Plants, 1834) notes "in the American species glands none in calyx or corolla." They are so easily noted in these specimens before me, that it is singular they should have been over-looked. There are four of these "setiforme bractlets" at the base of each floret, and they are slightly squamiform at the base. They are nearly alternate with the lobes of the calyx, starting from a little to one side of the sharp angle that terminates at the base of the division of the calyx. The setiform bractlet is just the length of the tube of the calyx, and if adherent to the calyx, the gland would be just where it is situated in the lobes of the corolla. No one can fail to see the gland on the corolla is the analogue of that on the setiform bractlet. We have no hesitation in concluding that there is primarily another

series of bractlets between the calyx and corolla, and that they have become confluent with the corolla. On this theory the lobes of the corolla should be opposite and not alternate with those of the calyx. After this theory had suggested itself, examination of the flowers showed it was correct. The lobes of the corolla are opposite the lobes of the calyx.

The close relationship of Rubiaceæ to Compositæ has often been remarked on. There are some correspondences in these observations worthy of note:—

Mr. Darwin remarks (Effects of Cross and Self-fertilization, p. 173, 1877) that "*Compositæ* are well adapted to cross-fertilization," and Professor Asa Gray (*American Agriculturist*) adopts the same view, referring to the ray-florets as if they were flags to attract insects. Adaptation, is however, chiefly inferred from the fact that the stigma, pushed up through the column of anthers, and covered with pollen, generally cleaves at the summit. The interior faces thus seem destitute of pollen, and must receive it from some external agency. The author of the present paper has, however, shown by careful observation on the flowers of Chicory, that the pollen grains fall into the cleft as the lobes of the stigma diverge. Many experiments by enclosing flowers of different genera in fine gauze, resulted in the florets seeding just as well as when exposed to the visits of insects. He has, therefore, always contended that the supposed arrangements for cross-fertilization in *Compositæ* were deceptive, and that the species are generally closely self-fertilizers. In further support of this view he has called attention to the fact that in plants conceded to be dependent mainly on external aid for pollen, a large number of flowers never get fertilized at all, while in self fertilizers failure rarely occurs. *Compositæ* come squarely into this class. The hermaphrodite florets rarely—one might also add, if ever—fail to perfect their seed. The remarkable fertility of the self-pollenized florets in the heads of *Cephalanthus*, deserve to be noted in correspondence with the self-pollenized florets of *Compositæ*.

The "bractlets" at the base of the flowers, are the analogues of the scales on the receptacles of *Compositæ*.

The bractlets, or a cycle of floral parts similar to and succeeding bractlets, unite with the corolla-tube, and form intra-lobular teeth in *Cephalanthus*. May not certain forms of seta (*Helianthus*, *Heliopsis*, etc.) be bractea that have become confluent with the calyx, their apices forming the setaceous teeth? It is difficult to determine

this point from the want of correspondence in number (abortion?) of some of the parts; but it is worthy of note that in the two genera just named, and others, where these teeth exist, a tooth is always alternate with the main "lobe" that distinguishes the ray from the tubular floret.

I think it will be conceded that, given a very little arrestation, development, union or separation of parts as we find them in *Cephalanthus*, it would not be difficult to construct a Composite flower.

Amorpha canescens, Nutt.—*Amorpha fruticosa*, has leaves glandular pellucid punctate, the dots being irregular in size. The legumes are covered by very large glands, also irregular in size. In the leaves of *Amorpha canescens* the pellucid dots are also irregular, and in many leaflets so indistinct that one should scarcely note their existence, only that we are looking for them. In the legumes, however, the glands are large and abundant, and readily observed through the dense mass of woolly hair that envelopes them. The point is worth noting. The carpels, morphologically leaves, usually have many characters suppressed in the progress of development from the primordial leaf to the carpel; but here we find characters existing in a marked degree in the leaves of an allied species, and nearly suppressed in its own foliage, reappearing as a strong feature in the legume.

During anthesis many interesting points present themselves. The anthers are fully formed and exhibit their yellow surfaces through the bursting sepals, when they seem to have their further growth arrested, and the pistil only elongates. It extends to double the length of the calyx. This is the work of the first day of opening. The next day the stamens lengthen, but one at a time. As soon as the first one has reached the exact length of the pistil, another starts into growth, then another, until towards the end of the day's work all are of about equal length. Soon after reaching its final growth the anther sacs burst, and thus one after another, in regular succession, the pollen is ejected from the cells. On the third day the pistil recurves, the apex forming a right angle with the base, and usually having its stigmatic apex in among the withered stamens of the flowers lower on the spike. All this time, the only petal possessed by the flower, the vexillum, has remained nearly quiescent. It projects its beautiful blue tint just a little beyond the calyx, the second day, after the last stamen has made its growth; but it is not till the third day that it makes a growth in earnest, when it goes on

rapidly, not, however, reaching quite the length attained by the stamens and pistil.

The observation worth recording here is that the bright corolla is often referred to in modern times, as being colored in order to attract insects to aid in the work of cross-fertilization. The colored corolla does not appear here until fertilization has been effected, which is evidenced by the recurving of the pistil. The orange-gold of the anthers would of themselves be sufficiently attractive; and the later effect of the vexillum, wholly superfluous, if mere attraction were the sole end nature had in view. Although the pistil matures a whole day before the stamens mature, the stigma receives the pollen often from the stamen of the same flower, or from those in the immediate vicinity, and which matured the day before, which is self-fertilization,—cross-fertilization being, according to Darwin, the reception of pollen from another plant. The flowers seem very grateful to the pollen gathering insects. After cleaning out the orange-colored pollen, from the woolly linings of the cell, by the insect, the empty white anthers, gave an additional interest to the orange and blue of the more perfect flowers.

The explanation of the late growth of the vexillum is evidently that growth is reflex—from the central axis downwards, as we see in *Liatris* and other *Compositæ*. After the axis, as represented by the pistil, has finished its growth, the spiral uncoils downward, and permits of the axial growths that the floral parts represent, beginning with the most advanced stamen, and running back to the petal, which of course would be the outermost verticil in the coil.

Oxybaphus hirsutus—*Oxybaphus*, says an old writer of the Linnean School "is a genus of the class *Triandria*." "The only known species is *Oxybaphus viscosus*. It is a native of Peru, and is nearly allied to *Mirabilis*, under which genus it is ranged by Cavanilles, but was made a distinct genus by L'Heritier, on account of its only having three stamina, and the calyx enlarged and peltate, attending the fruit." In those times to have three stamens was an essential character of the genus, In Gray's *Manual*, *O. nyctagineus* being the only one described, the genus has "stamens mostly three." In Coulter's *Flora of Colorado* "stamens usually three" is the record. As it is stated of *Mirabilis* by Coulter "stamens usually five," it is evident modern authors, equally with the founder of the genus, look to the number of stamens as in some measure a generic character. So far as I can find in works to hand, the number of stamens is not specially

noted in any description, except in the one case of *O. coccineus* in *Rothrock's Report of the Wheeler Expedition.* Choisey in DeCandolles *Prodromus* has "stamina 5" as one of the characters of the whole genus. In view of this uncertainty it is worth placing on record, that *O. hirsutus,* Sweet, always within my observations, has five stamens. I have had plants growing from seed gathered by me in Southern Colorado a number of years ago, and the plants uniformly have five stamens.

The flowers always open towards evening. On August 10th, I sat myself to watch their unfolding. At 4 P. M. one could just trace the pink color line, with a portion of a filament discernible; by 4·30 the stamens and pistil were fully exserted, over an inch in length beyond the perianth, the segments of the perianth were partially expanded, but were crumpled, and by 5 these were fully expanded, and the flower perfectly in bloom. Hundreds opened, but the anthesis of all was simultaneous. The involucre is three-flowered, but one opens first, and we may call this a central one. The two lateral open together the next day.

It is interesting to watch the expansion of the flower. The stamens in vernation are incurved. The anther seems to be caught in the imperfectly open flower. The filament, as it elongates, forms a loop. When the half hour of growth has been nearly reached, the perianth by that time expanding a little and, freeing the anther from pressure, the incurved portion springs suddenly forward, and instantaneously we have the long, straight, exserted stamen. In all that I noted the stamens proceeded thus: one at a time successively, the whole five occupying about two minutes to straighten out.

The flowers continue open all night; but commence to close by day-light in the morning.

I have noted on other occasions that some plants do not keep good time any more than some watches. I thought to repeat the observations on the evening of the 11th. Strange to say at 5 P. M. there were no more signs of opening than on the preceding day at 4. At 6 P. M. only one flower was open. At 7·30 they were all fully open as the day before at 5. It was a very dark and cloudy afternoon, heavy rain with lightning at 6·30. As most evening flowers seem favored by moisture and darkness, this contrary observation is worth recording.

The growth of the pistil coin
and is of equal length. The

reaching its full length. The pollen is remarkably large, there being only about 25 grains in each cell. The stigma seems receptive co-incident with the maturity of the pollen. There is nothing to suggest any special arrangements for cross-fertilization. The flowers are odorless. Moths visit the flowers freely. The moth remained a long time feasting on a single flower, generally from two to three minutes. It used the mass of filaments with the style for a platform on which to work for the nectar at the base of the style. Its motions would tend to shake the pollen out into the flower's own stigma and aid in self-fertilization. Large numbers of the flowers on my plants are barren. Many have not one, some have but one, and rarely are there two seeds in a single involucre.

Besides the three flowers that are produced in each involucral cup, a branch occasionally proceeds from the same axis. The flowers are usually regarded as apetalous, but a close examination of an opening flower is strongly suggestive of an amalgation of the corrolline and calycine whorls in one perianth. As the flower is opening the bud presents what a superficial examination would regard as a five-cleft calyx, with green-lance-linear and hairy segments, and it would be a surprise to an original observer to find a mono-petalous corolla, wholly in one piece with what appeared to be a distinct calyx. At the apex of one of the segments, and which by the way are alternate with what should be petals, there are two small pin-like, white glands; at the apex of another one gland; and at the apex of a third a small and imperfect one. This indicates that the elementary parts forming the floral whorl did not coil rapidly on its spiral course; as also does the successive development of the stamens; we may reasonably look for some irregular flowers among its congeners.

Irritability in the Stamens of Echinocactus.—It has been long known that the stamens of many Opuntias are irritable or sensitive when fully expanded under a hot sun. I have placed on record that this character extends to other allied genera. This summer I noted that the stamens of *Echinocactus Ottonis,* were particularly irritable.

Diurnal opening of the flowers of Magnolia glauca.—My brother Joseph called my attention to the fact, that cut flowers of *Magnolia glauca,* in water in our office, opened at 4 P. M. I found this to be the case also with plants growing in the open air, no matter whether the sun was shining, or the sky cloudy. They open at 4 P. M. but close

again before nightfall. The next day at 4, they open again, the anthers shed their pollen and then the petals close again. At 4 the third day they again expand, and continue expanded for some days till they fade.

NOTES ON THE ANATOMY OF ECHIDNA HYSTRIX.

BY HENRY C. CHAPMAN, M. D.

The specimen of *Echidna hystrix* upon which the following observations were made, lived in the gardens of the Zoological Society of Philadelphia about six weeks, spending most of its time entirely covered by the six inches of earth at the bottom of the cage. Its habit of feeding was similar to that of the ant-eaters, the tongue (Pl. XIV, 2) being slender and projected through the maxillary opening to the extent of about three inches. Under the artificial conditions of confinement it appeared sluggish. During life it was noticed that the position of the feet was such as to project the big toe outward, the soles being turned upward and backward.

A thick panniculus carnosus muscle covered the whole animal. A long slender muscle arose from the lower ribs on each side and was inserted in the soles of the anterior feet while a corresponding muscle arose from the tuberosity of the ischium to be inserted in the calcaneum. Otherwise there was nothing unusual about the muscles of the extremities. Those of the fore limbs were, however, enormously developed.

The salivary glands, (Plate XIV, fig. 2, *s*,) were of large size, two inches in length, with well developed ducts which terminated by small openings in the floor of the mouth. The small intestines were one hundred and two inches and the large, fifteen inches in length. The latter terminated in the cloaca (Pl. XV, fig. 2, *c*.) At the union of the small with the large intestines a short vermiform appendix was observed. The mucous membrane of the intestines was smooth throughout its entire tract, no valvulae conniventes being observed as in *Orinthorhynchus*. Peyer's patches were well developed in the small intestines.

Three vena cavae were present, two anterior and one posterior as in marsupials. Reta mirabile were observed in the iliac and brachial veins. The blood corpuscles were $\frac{1}{3000}$ of an inch in diameter, the blood itself being loaded with quadrilateral crystals.

The spleen (Pl. XV, 1.) was a triangular gland. The liver was four lobed and was provided with a large gall bladder. The pancreas was well developed, its duct, contrary to the usual arrangement, passing into the intestine at a point nearer the pyloric orifice than the bile duct. The kidneys (Pl. XV, 2, *k*.) were of equal size. The

two ureters passed into the urogenital canal, the bladder opening into the latter separately, as did also the vasa deferentia from the testicles. While the anterior extremity of the urogenital canal thus received the openings of the bladder, the ureters and the spermatic ducts, it divided at its posterior extremity into two passage-ways, the posterior of which led into the cloaca, the anterior into the peneal urethra.

The penis lay next to the wall of the cloaca and was attached thereto by fibrous tissue, the posterior ends being free and unattached to the pelvis. The glands were composed of four mammilloid processes provided with minute papillae. The posterior orifice of the urethra was probably pushed during coition towards the orifice of the spermatic ducts so as to form a continuous canal with the latter, thus preventing the escape of semen into the cloaca. No trace of a mammary gland was found.

The brain (Pl. XIV, 1) differed from that of *Ornithorhynchus* in being much convoluted. As regards the corpora quadrigemina, the nates were well developed but the lines of demarcation between them and the testes and between the testes themselves were very obscure. The corpus callosum was developed only in its anterior portion. The thalamus opticus and hippocampus major were remarkably prominent.

A little spur was present on the calcaneum as in *Orinthorhynchus*, but the gland and duct with which it communicated were much smaller and placed not so high up on the leg as in the latter. As this spur was present only in the male it may be a sexual appendage. The animal had been observed by Mr. A. E. Brown, the superintendent of the garden, to clean its spines by means of its hind limbs, and the secretion of oil from the gland which is discharged through the spur may merely assist in this process.

NOVEMBER 1, 1887.

MR. JOHN H. REDFIELD, in the chair.

Twenty-seven persons present.

The death of Frederick Graf Marshall, a correspondent, was announced.

Note on the Sense of Direction in a European Ant, Formica rufa.—Dr. Henry C. McCook remarked that during the summer he had made an observation upon the well known "horse ant", or

Formica rufa of Great Britain. While visiting the Trosachs of Scotland he found a number of nests of this species scattered throughout the glen known as the Pass of Achray through which flows the little Achray River, "the stream that joins Loch Katrine to Achray." These nests are found on either side of the foot-walk which leads from the Trosachs glen to "the sluices," as they are popularly called, which regulate the stage of water in Loch Katrine.

1. *Structure of the Ant Hills*—The mounds raised by the Rufous ants are heaps of earth intermingled with chippage of various sorts; they rise to the height of about three feet, and some of them are six or seven feet in diameter across the base. They stand amid the tall bracken which overhangs them, and at times almost conceals them from the passer by. The surface of the mounds is covered with bits of straw and leaves, stalks of grass and ferns and various material of like sort which forms a quite decided thatch. Numbers of openings appear upon the surface at irregular intervals from the summit to the base, and in the afternoon at 4 o'clock the workers in vast numbers were dragging the chippage back and forth apparently engaged in closing the doors for the night, although time did not permit an observation of the actual closure.

2. *Character of Roads and Engineering Skill.*—That which especially attracted Dr. McCook's attention was the character of the roads leading from the ant hills to the various points in the surrounding woods. These roads or trails were distinctly marked upon the surface of the ground, having in places a width of from two to four inches which was stained a dark brown or black, probably by the formic acid exuded from the insects; the leaves and grass upon which the trail was made were pressed down and smoothed by the constant action of innumerable legs upon the surface. So well marked were the trails that even without the presence of the columns of insects that thronged back and forth upon them, they were distinctly and easily traced. While following up one of these roads the observer was impressed by the fact that it showed scarcely any deviation from a straight line. In order to test this matter more carefully, he selected a large mound from which three roads radiated. These were all traced to their termination at three several oak trees, up which the columns of ants ascended in search of food supply from numerous aphides which infested the branches of the trees. The ant roads were then carefully marked out by stakes stationed at short intervals, a course which was made necessary by the fact that they were carried for considerable distances beneath the tall bracken, which had to be pushed aside in order to reveal them. The result of his observations is as follows:

Road No. 1 was 21 paces in length (about 65 feet) and was carried in an almost perfectly straight line from the nest to the terminal tree. No. 2 was 23 paces in length, (about 70 feet). It varied less than three inches from a direct line measuring from the nest to a point within two feet of the terminal tree. There the

column made a detour of about six inches from the straight line, but an abandoned path, continuous with the main road, which had apparently been used at a recent date, was traced for a considerable distance further without any deflection. No. 3 was the longest road of the three, being 34 paces in length. It extended for six paces in a straight line from the nest, at which point it touched an old stump which evidently deflected the path at a slight angle. From this point it was again continued in a nearly straight line as far as the beaten foot-path through the wood. Here the ant trail was obliterated by the friction of passing human feet, but the ants themselves thronged over the pathway in a column much broadened by continual interference and loss caused by foot passengers. The trail was, however, resumed at a point nearly opposite that at which it touched the path, and was continued again in a straight line six paces further to the tree, where it terminated. When the entire trail was staked off it was found that its terminus deviated less than three feet from a straight line drawn from the point of departure at the ant hill. The greater deviation in this case seemed evidently to have been caused by the peculiar difficulties in the chosen track. The three roads so radiated from the nest that they were included within about one quadrant of a circle, of which the two shorter trails might represent the radial boundaries of the quadrant, while the longer trail was drawn nearly midway between the two.

Taking the results of the three observations together it is manifest that the ants showed an accurate sense of direction in marking out and following their approaches to the trees. It would be scarcely reasonable to attribute such mathematical accuracy as above shown to mere accident. The roads in point of directness were as accurately laid down as ordinary roads made by the engineering skill of men. The skill of the ants was all the more apparent from the fact that their paths were carried through the jungle of bracken and various other wood plants. The same fact appears to indicate that the insects could not have been largely directed by the sense of sight.* It would perhaps be idle to speculate upon the manner in which this feat of emmet engineering was accomplished, as there were no facts observed which give a clue to the mode of proceeding, but the problem is one well worth study by naturalists on the ground.

3. *Engineering of Texas Cutting Ants.*—Dr. McCook in this connection alluded to an observation which has heretofore been placed on record[1] describing an underground route of the cutting ant of Texas, *Atta fervens*. This route extended 448 feet, entirely beneath the surface of the earth, at some places as deep as six feet, and hav-

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* The vision of ants is probably limited within a very short distance from the eyes; under any circumstances, therefore, it could have but little influence in determining such a phenomenon as here recorded. H. C. McC.

[1] See the anthor's Tenants of an Old Farm, p. 264; fig. 90.

ing an average depth of eighteen inches. From the points at which the ants came to the surface, the road was continued in a straight line 185 feet further to a tree in a gentleman's private grounds which the ants were engaged in defoliating. The entire length of the roadway was thus 669 feet, and the path as laid out by a young engineer who assisted in the observation, shows scarcely less deflection from a straight course than that of the Rufous ants recorded in the above observation.

4. *Sentinels.*—The longest of the three trails alluded to made by the Scotch ants terminated upon an oak tree which was also occupied by a column of ants from a neighboring hill. The two columns rigidly maintained their places on opposite sides of the trunk. Sentinels were scattered along either margin of both columns and these exhibited great watchfulness and sensitiveness to the approach of any object. Dr. McCook on approaching his finger to these sentinels observed that they seemed to perceive his finger when it reached a point an inch or an inch and a half distant from the bark. At once the ants thrust out their antennae, extended their heads, then the two front legs, and finally the middle legs thus hanging to the bark of the tree by the hind legs alone, the abdomen being slightly turned underneath the body as though prepared to eject formic acid upon any adversary. In one case at least the ant hung to the bark by one hind foot alone, extending the whole body in a perpendicular direction from the surface of the tree. It presented a grotesque appearance, and exhibited every sign of eagerness and vigilance in the discharge of its duty as watchman.

Several individuals were taken from one column and placed in the line of march of the ants from the other nest. They showed the usual evidences of strangeness and failed to fraternize, but on the other hand no one was assaulted by the passers by, a toleration worthy of note as showing some degree of community among the various nests of the one species.

The time which Dr. McCook could give to these observations was limited to several hours of a summer afternoon, which he spent as a tourist in this interesting mountain region, but they present some conclusions which appear to be reasonably decisive, and which at least may serve to stimulate further observations in the same line extending over greater periods and including a greater number of cases.

NOVEMBER 8.

MR. CHARLES MORRIS, in the chair.

Twenty-one persons present.

NOVEMBER 15.

The President, DR. JOS. LEIDY, in the chair.

Twenty-five persons present.

Papers under the following titles were presented for publication:—

"Note on Achines lorentzi Weyenburgh." By David S. Jordan.

Description of two new species of Fishes from South America." By David S. Jordan.

Geological Results of the Boring of an Artesian well at Atlantic City, N. J.—Mr. Lewis Woolman stated that there was commenced in the summer of 1886 at Atlantic City, N. J. an artesian well, the drilling of which has been since continued with some intermission until, at the present time, a depth of 1121 feet has been reached. During a recent cessation in the work caused by delay in the receipt of pipe for tubing the well he had been permitted through the courtesy of the gentlemen interested in the enterprise to turn over and examine the sands, clays and marls accumulated in the dump heap and had found many fossil representatives of life forms, including a bone—the articulating end of a femur or humerus of an animal belonging to the Crocodilia,—presented by Dr. T. K. Reed, and a few shells and fish teeth presented by Jas. H. Moore, engineer in charge. There have been obtained from the well 52 species in all, 42 being mollusks. Many of the smaller shells were entire and quite perfect but most of the larger ones were fragmentary, having been broken in pieces by the drill. James H. Moore also kindly furnished a minute description of the thickness and character of all the sands passed through, by a careful examination of which and a grouping of the smaller seams with the larger ones that give character to formations, the speaker had constructed the following section:—

Sands.	First	285 ft.	Superficial Sands, Gravels and Clays. Wood found at the base.
Clays.	285 ft. to 416 ft. =	131 ft.	Black Clays and Sands.
	416 ft. to 435 ft. =	19 ft.	Bluish Clay.
Clays and marls with fossils	435 ft. to 670 ft. =	235 ft.	Greenish Clays and Marls with much comminuted shell; some shark teeth and many seams of brittle marly clay of gray color.
Sands.	670 ft. to 691 ft. =	21 ft.	Blackish and brownish sands.

Clays with fossils	691 ft. to 722 ft. =	31 ft.	Chocolate Clay.
	722 ft. to 806 ft. =	84 ft.	Fossiliferous Clays and sands; shells and sharks teeth.
Sands.	806 ft. to 866 ft. =	60 ft.	Non-fossiliferous sands, alternating blackish, whitish, and reddish brownin color.
Clays.	866 ft. to 939 ft. =	73 ft.	Dark Marls and Clays.
Marls.	939 ft. to 999 ft. =	60 ft.	Green marls (various shades) and black marls.
Sands.	999 ft. to 1119 ft. =	120 ft.	Sands mostly yellowish green and full of barnacles.
	1119 ft. to 1121 ft. =	2 ft.	White Sands. *Water* flowing to surface.
	Total	1121 ft.	

Prof Angelo Heilprin has kindly and very carefully examined and identified all the specimens of fossils. The speaker has placed to the right of each in the following list, the range along the Atlantic Seaboard where out-crops containing the same fossils have previously been found—the names of the formation being those established by Prof. Heilprin in his Tertiary Geology, in which the formation in in the state of Maryland is divided into an older and a newer group:—

Miocene
- Marylandian, Older Maryland group.
  = Lower Atlantic Miocene.
- Virginian, Newer Maryland group and deposits of Virginia.
  = Middle Atlantic Miocene.
- Carolinian, Deposits of North and South Carolina.
  = Upper Atlantic Miocene.

Anomia (probably *ephippium*).	N. C. S. C.
Arca centenaria,	N. J. Newer Md., Va., & S. C.
Arca subrostrata,	Older Md.
Arca (*idonea?*)	Newer Md., Va., N. C.
Arca (*lienosa?*)	N. C. S. C.
Artemis (*acetabulum?*)	Newer & Older Md., Va., N. C.
Astarte compsonema,	N. J.
Astarte obruta,	Newer Md.
Astarte perplana,	Newer Md.
Astarte Thomasii,	N. J.
Cardita granulata,	Newer Md., Va., N. C., S. C.
Cardita arata,	N. J. Newer Md., Va., N.C., S.C.
Crassatella melina,	N. J. Older Md., Va., N. C.
Corbula idonea,	Newer and Older Md.
Corbula elevata,	N. J. Older Md.
Cardium (probably *laqueatun*),	N. J. Va.

Cytherea,	
Discina lugubris,	N. J.
Donax (variabilis,?).	
Fulgur,	
Lucina trisulcata,	S. C.
Mactra lateralis,	N. J.
Mactra ponderosa,	Newer Md.
Mytiloconcha incurva,	N. J. Older Md.
Mytilus incrassatus,	S. C.
Mysia,	
Natica catenoides,	N. J.
Nassa trivittata,	N. J. Newer Md., Va., N. C. S. C.
Nucula obliqua,	N. J. Va., N. C.
Ostrea,	
Pecten Madisonius,	N. J. Newer Md., Va., N. C.
Pecten Humphreysii,	N. J. Older Md.
Pecten vicenarius	
Perna maxillata,	N. J. Older Md., Va.
Tellina subreflexa,	
Tellina declivis.	
Turritella Cumberlandia,	N. J.
Turritella æquistriata,	N. J.
Turritella plebeia,	Newer Md.
Turritella (sp. not determinable),	
Turbinella Woodi,	N. J.
Venus.	
Barnacles,	Crustacea.
Femur or humerus,	Crocodilia.
Tooth,	Gavial.
Tooth *Lamna compressa,*	Shark.
Tooth *Odontaspis,*	Shark.
Tooth, species not determinable,	Shark.
Teeth *Myliobates,*	Fish.
Spine of *Echinus,*	
Dendrophyllia,	Coral,
Polyzoan,	

James H. Moore had noted the depth from which the specimens furnished by him had been taken; with this information and an examination of the sands of the dump and their contained fossils, it may be safely concluded that of the above:—

Turritella plebeia came from a depth of about 450 ft.
Corbula elevata came from a depth of about 730 ft.
Perna maxillata came from a depth of about 800 ft.

The paleontological evidence indicates that the portion of the section between 400 and 700 feet belongs to the Middle Miocene and all below that to the Lower Miocene.

About 15 of the above species, it is believed, have never before been found in New Jersey. These are from the upper layers (Middle Miocene) which no doubt exist further back from the shore, say

about 30 miles N. W., where they are buried beneath 50 to 100 feet of more recent Tertiary sands and gravels.

Most of the other species (Lower Miocene) that have previously been noticed in the state occur at Shiloh, near Bridgeton, in Cumberland County, while others are found in Salem County. The lower strata from which they were obtained also probably exists in a direct N. W. line 33 to 35 miles from Atlantic City; but these are likewise covered by more recent Tertiary strata.

NOVEMBER 22.

REV. HENRY C. MCCOOK, D. D., Vice-President, in the chair.

Twenty-eight persons present.

Note on Cyrtophora bifurca and her cocoons, a New Orb-weaving Spider.—Dr Henry C. McCook remarked that during a temporary stay in Florida, April 1886, he found nested upon the porch of Dr. Wittfeld's place, Fairyland, Merrit's Island, on the Indian River a little way below Rockledge, a spider which appears to be new to science. Its snare resembles that of *Cyrtophora caudata*, Hentz. It also resembles that spider in the manner of hanging its cocoon string in the vertical axis of its orb just above the hub. The character of the cocoon, however, differs entirely from that of *caudata*. It is in the shape of a somewhat irregular octogon, and is of a light green color. The speaker had found as many as twelve cocoons in one string overlapping one another in the manner which he had frequently observed with the cocoons of the Labyrinth spider, (*Epeira labyrinthea* Hentz) and which may also be seen at times with the cocoons of *caudata*, although for the most part, the latter are arranged at intervals along the string.

The cocoon strings collected varied in the number of cocoons attached thereto,—probably according to the period of advancement in the process of ovipositing on the part of the mother. Of the specimens collected one string contained 14, another 12, and another 10 cocoons. They are bound together along one side by continuous series of thick white threads which extend from the top to the bottom of the string. Each cocoon consists of two parts which have evidently been fastened together by a selvage. These parts present the appearance of two dishes placed together edge to edge. They are woven of a soft but rather tough texture. A very slight tuft of flossy white silk is found inside, and within this the eggs are deposited. In one cocoon of a string of thirteen, twenty five minute dead spiders were counted which had passed their first moult. In another cocoon taken from a string of five only, there were twenty six. The number varies a good deal, however. The cocooning period appears to extend into May; at least Dr. McCook had received from Miss Anna Wittfield, as late as the middle of June, a string in which were some cocoons empty, one with spiderlings passed the

first moult several days, and another with young who had just broken the egg. There was no trace of the bifurcated abdomen upon these younglings.

The spider is of a uniform light green color, about the shade of its cocoon. The cephalothorax is of the same color as the abdomen; in this respect differing from *caudata* which is black. The head also is not so much elevated as is that of *caudata*. The adult female is three-eights of an inch in length, and the only specimen of a male obtained is about three-sixteenths of an inch in length, although it is an immature specimen apparently lacking one moult of maturity. The most striking characteristic of the female spider is that the conical prolongation of the abdomen which marks the genus is distinctly cleft at the apex, giving it thus the appearance of the tail of certain fishes and birds, and for this reason it is named *Cyrtophora bifurca*. In this respect it decidedly differs from *caudata* whose apex is without a cleft. On the basal part of the dorsum of the abdomen are four conical processes arranged two on each side symmetrically, the hind pair being the smaller. These processes are soft resembling thus the like cones on the abdomens of the Angulata group of Epeiroids rather than the tough spinous processes upon *Acrosoma* and *Gasteracantha*. The spinnerets are surrounded by a broad white band which extends along the venter as far as the epigynum. The lip is sharply triangular, and the mandibles cut square across. In both these respects the species differs from *caudata*. The eyes of the front row are about equally separated from each other, although the interval between the mid-fronts is slightly less. The side eyes are barely separated from each other. The male specimen alluded to above, Dr. McCook could not certainly affirm to belong to this spider. It resembles *caudata* in its general appearance, the abdomen lacking the bifurcation which marks the female, and the cephalothorax being of a jet black.

NOVEMBER 29.

The President, DR. LEIDY, in the chair.

Twenty-nine persons present,

The following were elected members:—

Messrs Garvin W. Hart, Charles A. Davis, Rev. R. H. Fulton, D.D. and Miss Mary E. Shively.

Orville A. Derby of Rio Janeiro was elected a correspondent.

The following were ordered to be printed:—

ON THE HOMOLOGIES AND EARLY HISTORY OF THE LIMBS OF VERTEBRATES.

BY JOHN A. RYDER.

I. The imperfect serial homology of the limbs of Vertebrates.

That any one should seriously question the complete homology of the anterior and posterior pairs of limbs as found developed in the great classes;—Mammals, Birds, Reptiles, Amphibia and Lyrifera, (*Ichthyes*, or all fish-like vertebrates, except the Lampreys and Hags,) is, perhaps, at first thought, a somewhat startling proposition. The fact that there is an imperfect homology or a want of exact morphological equivalency between the parts of the same pairs of limbs in different forms, has been tacitly admitted by such of the transcendental anatomists as Gervais and Gegenbaur, and those anatomical philosophers who have been influenced by their *a priori* methods, in developing which, certain suppositions had to be made, which at the time, could not be or were not verifiable or refutable from data supplied by general ontogeny or embryology. The case stands differently to day. Since Gervais and Gegenbaur wrote on the theory of the limbs, owing mainly to the remarkably fruitful labors of Haeckel, Balfour and Dohrn, the great morphological problems presented for solution by the organizations of the diverse classes of vertebrata, have presented themselves under entirely new aspects. These are not only momentous as affording a key to the interpretation of the anatomy of the adults of the different types, but also as throwing a not inconsiderable amount of light upon the relations and taxonomy of the major groups.

That the paired limbs have been derived from some common, simple ancestral form of limb, is, I cannot help but believe, proved by the following general truths:—

1. In the most undeveloped condition, the first traces of the paired limbs of all vertebrates, find formal expression as low longitudinal, lateral projections of the body, and lie in a plane parallel with that of the axis of the latter. This fact originally observed by K. E. von Baer, has in part afforded J. K. Thacher, F. M. Balfour, and St. G. Mivart, the basis for a theory of the development of the paired limb, but it remained for A. Dohrn to discover that there existed a continuous series of vestigiary structures in certain forms which connected the anterior and posterior limbs together into a

continuous chain of serially homologous or homodynamous elements These lateral elements of the limb, are therefore, to be regarded as metameric structures, in that they correspond with the metamerism of the body. The fore and hind limbs are, therefore, and presumably in all forms, to be regarded as directly or indirectly differentiated from a *single* pair of lateral folds, it matters not in what way the process may be obscured by extreme secondary modifications or specializations of development.

2. The subsidiary doctrines which confirm the preceding, may be stated as follows:—

a. The lowest truly limb-bearing vertebrates are the only ones in which the lateral folds, from which both pairs of limbs are derived, are continuous or which show a continuous series of limb-buds under the integument along either side of the embryo.

b. This lowest limb-bearing group is also the only one in which the branches of the paired spinal nerves, which pass out to the metamerically repeated limb-buds, ever form a continuous series, or in which the paired limbs maintain their primordial horizontal position.

c. The group here referred to, the *Elasmobranchii*, is, moreover, primitive in many other ways, especially as respects:—(1) or histological development, in that no parosteal or membrane bones are developed, as in the higher types, and, (2) or morphological development, in that the branchiæ are at first naked, with no operculæ in the adult; skeleton principally cartilaginous; distal part of vertical fins and paired limbs, supported and stiffened by actinotrichia above, with shagreen or dermal spines covering them; teeth generally successional from a thecal fold, and transitional to the spines or denticles found in the common external tegumentary covering of the body; no air bladder or pneumatic apparatus; shoulder and pelvic girdles simple; jaws and mandibular arch simple, suspended directly to the skull; a wide, spiracular, branchiferous cleft; generative and renal apparatus of a primitive type; muscular buds, which are thrust into the median and paired limb-folds, with traces of a lumen or cavity, which has been derived from the cavity found in the myotomes, from which the muscular buds have been derived as outgrowths or diverticula.

This evidence is quite sufficient for us at present to build upon, for the Ascidians, Leptocardians and Enteropneusta have no claim, as based either upon their morphology or upon their ontogeny, to

be regarded as forms ancestrally or phyletically related in a direct line to the limb-bearing vertebrates. It will probably be best to regard all of these, including the Lampreys and Hags, as extreme retrograde modifications or as adumbrations of something higher in the Chordate series, and indeterminate in every respect to their exact position with reference to the great limb-bearing phylum. The *Elasmobranchii*, therefore, alone remain as a point of departure.

It is not possible to develop a rational interpretation of the inexact homology of the paired limbs of the various types, in which it may be suspected to exist, unless we start with the *Elasmobranchs*, because, in the latter only, do we find the limbs in a condition which there is every reason to regard as the most primitive. The principal mark of this primitiveness is, as before stated, the continuity, at a certain stage, of the limb-rudiments, the elements of which are, moreover, metamerically repeated, that is, they recur as out-growths from each and every successive myotome of the series underlying the paired integumentary folds, from portions of which, together with a greater or lesser number of the underlying muscular limb-buds and other mesoblast, the permanent limbs are finally differentiated. It is probable, therefore, that the lateral limb-folds of this primitive type may be regarded as typifying almost completely the ideal form from which all of the various types of paired limbs have been evolved, as seen in the various groups. That such a generalized (not archetypal) ancestral form may be assumed to be represented by the most generalized Elasmobranchs, (Rays and Torpedos) will, I believe, be fully justified by the evidence, which remains to be offered in what is to follow.

While the method by which limbs are developed in Sharks and True Fishes, must be admitted by anatomists to be primitive, it must not be forgotten that long limbs of functional value, such as are possessed by Land Mammals, Birds and Reptiles, would be next to useless and an actual impediment in the struggle for existence, if appended to a fish. That this is true, is proved by the fin or paddle-like limbs of Plesiosaurs, Ichthyosaurs, Cetacea, Sirenia and Pinnipeds, in all of which there has occurred a gradual abbreviation, modification and even change of the position of the limbs, in order to economize the exertion of effort in a dense medium—water—in which short, fin-like limbs only would be preserved by *mechanical selection*. That is, the limb which presented the greatest mechanical advantages would be the one preserved, while its adaptation—modi-

fication in a determinate direction (not hap-hazard, through fortuitous variation,) would be conditioned by definite retroactions between the organism and its environment, and thus gradually stamp it with peculiar and mechanically advantageous features. This view should not be lost sight of; and, while it has been demonstrated to the satisfaction of all anatomists, (except P. Albrecht, whose views as to the primitive nature of the Cetacea are not borne out upon either morphological or palæontological grounds,) that, the aberrant forms alluded to above, are in all probability descendants of land and semi-amphibious types, we are forcibly reminded by these examples, of how the evolution of strongly marked types is directly conditioned by the peculiar nature of their specialized environment.

This brings us to the question of distribution in time, or the sequence of forms. Here, palaeontology comes to the aid of the morphologist and affords the final proof that the Fishes are veritably the oldest of the limb-bearing vertebrates. The evidence derived from ontogeny, comparative morphology, taxonomy and palaeontology is, therefore, in accord and quite conclusive as to the main fact of the primitiveness of the fish-like type, which is, therefore, the only one which can be regarded as affording the direct ancestral means through which the structural condition of the limbs of higher forms may be reached.

The mediate or indirect ancestry of the higher vertebrate types, was undoubtedly, one in which there obtained a condition even more primitive than in the most generalized of the limb-bearing fishes. Such a type was one which probably differed from the most generalized fish, in having the metameric elements of the paired limbs distinct for each segment; and not coalesced or fused into a more or less closely connected longitudinal series, covered by a simple, common fold of integument as in the latter. The only types which approach such a condition, are the existing Errant Annelids or Worms. These, or some peculiar generalized forms of Worms were therefore, the probable prototypes of the vertebrates as maintained by Dohrn and Semper, and, thanks to the brilliant researches of Bateson upon *Balanoglossus*, such a view has more in its favor now than ever before. Yet, here again the unwary must be cautioned, since *Balanoglossus*, living as it does buried in the sand, has probably undergone some retrogressive metamorphosis, so that it has been itself modified and diverted out of the path leading in the direction of the descent of the true vertebrate forms.

The presence of two lateral rows of vestigiary structures, in the position of parapodia, on either side of the tail of embryos of certain *Elasmobranchs*, and on either side of the dorsal median line, opposite the interval where the vertical dorsal fins are wanting, as first described by P. Mayer, led that investigator to regard such vestiges as *parapodoid* in character.

The existence of vestigiary structures of this kind, as well as their segmented or metameric relations, which are essentially the same in their general features, as those of the metameric elements of the limbs themselves, lends additional probability to the doctrine, that the vertebrates are the off-shoots of a worm-like ancestral form.

The suppression of the caudal parapodia or radial elements of the fins in the ancestral types, which led to the differentiation of the paired fins, may be ascribed to a number of other influences besides those referred to by Dohrn, of which the following may be mentioned,

1. If the ancestral type has been one which was at one time tubicolous in habit, the abortion of the caudal parapodia would be accounted for. Though, it must be admitted that this view is in the highest degree improbable, but not impossible.

2. The late outgrowth of the tail in annelids as well as in vertebrates, presupposes a belating of the functional activity of the caudal parapodia, through which their importance and development may have been hindered.

3. The slight use made of the parapodia of the tail as locomotive organs, after the tail became laterally flattened or compressed, since it is well known that the principal power of propulsion exerted by fishes, is by means of the alternate flexures of the tail; the fins aiding only in a moderate degree, their principal office being to balance or hold the body and keep it in the normal position. The exceptions to this rule are very few; the most important being that of *Mola* in which the dorsal and anal fins are the sole organs of locomotion, as shown by the writer elsewhere.

The abortion of the caudal part of the intestine, now represented by the post-anal gut, as it is termed by embryologists, may have had something to do with the development of paired limbs over the sides of what remained of the body cavity, as urged by Dohrn, but there must have been forces at work which led to this abortive process, by which the primitive gut was shortened. And, while it is undoubtedly a fact that such a shortening of the alimentary tract

has occurred, giving rise to the gutless and acœlomatous tail of a number of classes, the shortening has been compensated for by the development of intestinal coils, diverticula, pouches, rugae, folds, follicles, crypts, glands, valves, etc., thus increasing the efficiency of the anterior portion of the alimentary canal as a digestive apparatus, so that the hinder part became useless, thus leading to its suppression. This seems to have been the cause antecedent to the one invoked by Dohrn.

Accepting the morphological part of the theory of Dohrn, as to the phylogeny and ontogeny of the paired and unpaired limbs, a difficulty has arisen as to how the parapodia became mainly dorsal and ventral, if, as is supposed, they are derived from an ancestry in which they were lateral. The view that the presence or absence of the alimentary canal was an efficient cause is beset with grave difficulties. A view which seems to me to be far more probable, rests upon the exaggerated development of a very different set of paired structures in the lower vertebrates, namely, the myotomes. The homologous tract in the Annelids is almost equally developed around almost the entire circumference of the somites, whereas in the vertebrates their development is almost wholly lateral, especially during the early stages.* The bilaterality of the muscular system thus finding expression in the much thickened or laterally hypertrophied somatopleure of the primitive vertebrates, would inevitably crowd the notopodia and neuropodia of the ancestral Annelid, toward the ventral and dorsal edges of the body; the infolding of the medullary groove would divide the somatopleure in the middle line, and the growth forward of the stout notochord would tend greatly to aid from beneath, in breaking the continuity of the somatopleural layer across the median line. The suppression of the dorsal moieties of the body cavities in the myotomes would also aid in effecting the needed change.

With the advent of a laterally hypertrophied somatopleure, flexures of the body in the ventral or dorsal, as well as lateral direction would no longer be so well marked, and the habitual flexures of the body now established, would be alternating ones from right to left; thus, the habitual mode of flexure of the body of fishes would be attained. The mode in which muscular contractions resulting in the manifestation of movements would thus become more specialized than in the annelids and be brought to the stage observed in the lower vertebrata.

The less marked development or thickening of the somatopleure over the lateral and ventral parietes of the body-cavity, in the primitive vertebrates, would doubtless tend to affect the position of the notopodia, from which the paired limbs are supposed to be derived, causing them to retain their primitive place.

Thus far, only the ontogenetic theory of the limbs has been discussed, in order to prepare the reader for the evidence which is now to be presented; many of the data are from personal studies, and such old data as I have found available, I trust, will be brought into such contrast with the others, as a whole, as to bring out their morphological significance.

II. The proof of the inexact homology of the limbs of different types.

The inexact homology or equivalency of the limbs of different types of vertebrates has been suspected by authors, but no observations or systematic comparisons have been put upon record to show that there were good morphological grounds for such a conception of the nature of limbs. The exact morphological equivalency of the pairs of limbs of different types, would require that they arise from the sides of the same segments or somites behind the skull, for each pair, in all species of vertebrates. If, for example, the limb-bud of the pectoral or fore-limb arose from the fifth to the eighth post-occipital somites in all vertebrates, there could be no question that the fore-limb in one was the exact homologue of the fore-limb in every other form. Unfortunately, the facts of development and comparative morphology unequivocally compel us to admit that such is not the case.

1. *Embryological evidence, considering especially the points of origin of paired limbs.*

The positions in which the limb buds of the same pair arise in different types varies between wide limits, and, while there are causes which in part explain these variations, there are some complications involved which refuse any other explanation except that which supposes, that such variation in point of origin is an indication of inexact homology,

It may be stated as a general trnth that, the paired nerves which go to a given limb have arisen from the somites, which were opposite or beneath the limb bud or fold, from which that limb developed. This may be shown to be true in the lower forms nearest the primitive type, from which all others may be supposed to have arisen. For example, the pelvic pair of limbs of physoclistous Fishes at first

grow out close behind the pectoral limbs, with little or no intervening space between them, but notwithstanding this fact, and in spite of an extensive subsequent translocation of the pelvic limbs forward into a position in advance of the base of the pectorals, the paired nerves which go to the pelvic limbs retain their primary origin behind those which pass to the pectorals. In the adult physoclists, therefore, the nerves going to the pelvic limbs, cross below those going to the pectorals, on their way to the pelvic limbs. This retention of the original nerve origins is in itself the best proof that we can depend upon to give us a clew to the groups of somites from which a given limb has arisen.

In many cases the origins of the paired nerves passing from the cord are much further forward than the foramina or intervertebral intervals which give them exit. This difficulty is probably quite explained away by the manner in which the vertebral canal grows in length compared with the cord. It is found, in fact, that the vertebral canal grows in length much faster, in many forms, than the cord, after a certain period. This causes the origins of the spinal nerves from the cord to appear as if they had been drawn forward some distance in advance of their points of exit from the sides of the vertebral canal! That this is a true explanation is proved by the fact that Kölliker has found the cord extending the entire length of the vertebral canal in the human embryo of three months, while the writer has found the same condition in the embryos of Cetaceans, two inches in length. It is, therefore, obvious that the cauda equina in these cases is developed at a later period, and as a result of the growth in length of the spinal or vertebral canal at a more rapid rate than that of the included cord itself. Similar phenomena occur in the cases of certain fishes (*Lophius*) and Goette has described the process in *Bombinator igneus.* In this last case, however, there is more or less positive atrophy of the posterior end of the cord in the course of development, so that only about 14 pairs of spinal nerves can be finally identified. In *Mola*, not only the cord, but the tail is also aborted to such an extent that only a very short, almost occipital, cord remains, the paired nerves passing directly to the lateral musculature of the vertical and paired fins, after forming a dorsal cauda equina. The cord in the long, flagelliform, reduced tail of the two Lyomeri, viz: *Gastrostomus* and *Ophiognathus*, shows unmistakable signs of atrophy or degeneration, in that the cord in the tail becomes so reduced to a mere flattened filament, that it is

with great difficulty that the white and gray matter can be distinguished in sections, or that any differentiation, except around the central canal, is visible.

In the singular and remarkable case of the Cetacea the embryological evidence, here offered, is entirely reconcilable with the views for the first time propounded by the writer upon morphological grounds, that the distal portions of the hind limbs are represented by the flukes. The latter being in reality the outward vestiges of hind limbs, so that the statement in recent text-books to the effect that, "the Cetacea are without hind limbs," must be qualified. The morphological evidence attainable proves beyond a resonable doubt that the distal part of the hind limbs have been translocated backwards into their present position in Cetaceans, through the intermediation of a type approximating the existing pinnipeds, in which a similar process is now taking place.

In the Cetacea, the translocation of the hind limbs has been in a backward direction or just the reverse of what has occurred in the physoclistous Fishes. The Cetacean "lumbo-caudal plexus" which at least furnishes the sensory branches of nerves going to those organs, is therefore, either a backwardly translocated structure, similar in character to the forwardly translocated pairs of nerves going to the pelvic limbs of Physoclists, or it may be that they represent the modified posterior part of the system of spinal nerves, which supply the muscles of the powerful tail and have thus acquired secondarily a more intimate relation to the flukes. At any rate, the nerves, in this case, give us a far less potent argument in favor of translocation than do the skeleton and muscles, which are alone conclusive, when contrasts are made between their condition in the normal Mammalia, the pinnipeds and the Cetacea as the last extreme of modification.

But backward translocation of limbs is not confined to Cetacea. In all fishes so far observed by competent embryologists the pectorals grow out on either side of the anterior end of the trunk as a pair of folds just behind the last pair of branchial arches. In one group however, the embryology of which is not known, and which will in all probability remain inaccessible to us for the reason that, both *Gastrostomus* and *Ophiognathus*, the genera referred to, are abyssal forms, there is every reason to believe that the pectoral pair of fins has been translocated backwards. In the case of *Gastrostomus bairdii*, this translocation has pushed the pectoral fins

back out of their usual place, over about thirteen segments beyond the occiput, and the translocation of the pectoral of *Ophiognathus* is scarcely less. In both these cases the translocation is due to the extension backward of certain portions of the inferior arches of the skull, and of the mouth, as a result of which, the branchial apparatus and heart have also been displaced and lost their attachment or contiguity to the skull, while the carotid arteries have been lengthened to an extent which is altogether without a parallel amongst fishes.

Amongst median fins the anterior dorsal of *Lophius* is known to undergo considerable displacement forward, according to the published figures of A. Agassiz, showing the development of this form. Even in the history of the metamorphosis of the tail in heterocercal types, I have attempted to show (Origin of Heterocercy) that associated with the deflection upwards of the end of the caudal axis, due to a definite combination of mechanical conditions, there has also occurred a translocation forwards, crowding together of the inferior basal and hæmal supports of the caudal rays.

Turning again to the evidence, purely morphological and embryological, we find that the last pair of spinal nerves in *Phocœna* make their exit at the 45th vertebra, in Man at the 27th, in *Lepus* at the 29th, which facts when contrasted, sufficiently prove that there have been changes in the position of the source of the innervation of the limbs. The additional evidence which we possess showing that the hind limbs of the Cetacea and Sirenia have suffered displacement and may not be exactly homologous with the hind limbs of other vertebrates, consists in the fact that the hinder limb-buds (future flukes) grow out at the sides of the cylindrical tail and but slightly in advance of its termination, as low horizontal folds which have degenerated into the flukes, which now consist internally of the lowest grade of tissue, viz: fibrous connective, covered by the closely adherent integument.

In violent contrast to this we have the mode of development of the limbs of the *Physoclisti* at a parallel stage as buds or outgrowths immediately behind and with scarcely an interval between themselves and the rudiments of the pectorals immediately in advance of them. As a result of this, the paired spinal nerves which innervate the pectoral and pelvic limbs, form a continuous series with no interval whatever between them as shown by the accompanying table, while the greatest interval between the last brachial and first

lumbo-sacral nerve is found, as would be expected, in *Phocæna*, where it aggregates 16 pairs, according to the same table. We are accordingly forced to admit that the nerve supply going to a given limb is correlated with the position along the axis, at which it first grew out in the embryo.

If it is still insisted that these comparisons are unfair, I shall now propose some fresh difficulties to be disposed of by objectors to my thesis, that, pairs of limbs which are apparently exactly homologous upon superficial inspection are not necessarily the exact homologues of each other.

Take the cases of *Cottus* and *Esox*, if you please. We find here that in the first there is a continuous series of not more than seven pairs of nerves, reckoning from the occiput, which supply both the pectoral and pelvic fins. Turning now to *Esox*, we find five pairs of post-occipital nerves, which send a nerve supply to the pectoral, then follows an interval of twelve pairs of "intercostals," and it is only when we reach the 18th post-occipital pair, that we first find nerves which pass to the pelvic limb; eight pairs in all sending branches to that limb, so that, according to the old view, we have the preposterous conclusion that, the 25th pair of spinal nerves in *Esox* are the homologues of the 7th pair in *Cottus!*

We find in these two cases, moreover, that the rudiments of the pelvic limbs do not grow out at the same point, in respect to the median axis, but in the embryos of *Cottus* far in advance of the point of origin of the same fin in the embryo of *Esox*. And in proof of the fact that the pelvic fin of *Cottus* has not been derived by its migration forwards in the embryo, from a more posterior position similar to that in the embryo of *Esox*, we have the fact that we have no embryological evidence whatever, to show that such a translocation occurs. In fact, the rudiments of the pelvic fins grow out from the sides of the embryo in both genera in exactly the position required by the position of the nerve supply in the adults.

Further, is it to be supposed that in a Bird, where there are about ten post-occipital pairs of nerves which have nothing to do with innervating the wings, it would be fair to compare the first five of these which have no direct relation to the fore-limb, with the first five post-occipital pairs in *Esox?*

Here again, the embryological evidence is conclusive, since in Fishes generally, the pectoral fin-fold grows out immediately behind the last branchial arches and from what would be the cervical re-

gion in the bird, and *Esox* is no exception to this rule. In the Bird (Chick and Sparrow), I find, just as was to have been expected, that the pectoral limb-bud (wing) does not grow out from the sides of the cervical or anterior region of the trunk as in Fishes, but some distance behind it. In fact, a corresponding number of somites intervene between the hindermost limit of the cranium and the anterior margin of the fore-limb of the embryo bird. This gives to young embryos of birds their peculiar long necked appearance, because their necks are absolutely longer for morphological reasons than those of other warm-blooded vertebrates. We find indeed, that the fore limbs of birds are separated by a wider interval from the oral opening or the base of the skull, than those of Mammals. This fact will be palpably brought out, if two series of embryos of Birds and Mammals of approximately the same relative stages are laid side by side and compared. It will then be seen that the first traces of limb-buds in Birds arise farther back from the head than those of Mammals, thus clearly showing that the fore limbs, in the two cases, do not arise from serially equivalent somites,

The fore-limb of the Bird, therefore, grows out and develops at a point posterior to that at which the fore-limb of the Fish is developed; the segmental elements which enter into the formation of the fore-limb (pectoral) of the fish, are therefore not homonymous with those which enter into the formation of the fore-limb (wing) of the bird. Nor can less be said when we come to compare the early stages of the Bird and Mammal.

This failure of the limbs to arise from an exactly homonymous series of successive segments in different groups, shows in the clearest manner that such difference in origin unquestionably implies the existence of inexact homology, with all the morphological consequence which must follow.

We have also seen that sudden or rapid forward translocation of the hind limbs during their early stages, occurs only amongst Physoclists, where it has been repeatedly observed in different genera. In Cetacea, I have elsewhere sought to explain the peculiar method of their backward displacement in another manner, while the cases in which it is more than probable that the fore-limbs undergo rearward displacement include only one type of Fishes viz: the Lyomeri. In no others except Pinnipeds does there appear to be the slightest evidence of the occurrence of translocation. The defenders of the Archipterygium hypothesis are, therefore, so far as they would avail

themselves of the theory of the translocation of the limbs, left with nothing to rely upon. Even supposing that the phylogenetic history is inaccurately repeated in the ontogeny of the forms here used in illustration, how will we explain on such a supposition, the persistent posterior origin of the pelvic limbs in Physostomes from folds separated by an interval of as many as 20 somites from the pectorals, while in Physoclists there is either a very small interval or almost none; and why is it that the nerve supply for the limb should be derived so constantly from the pairs underlying the point of origin of the limb-fold? We saw, moreover, that when translocation did occur during ontogeny, that the distal portion of the nerve supply was carried along with the limb, while the point of the origin of the nerve supply remained unchanged. The other cases of translocation, which are well made out, the Cetacea and Lyomeri are not fairly to be contrasted with that of the Physoclisti, because, in the first instance the hind limbs have become totally incapable of free or independent movement, while in the case of the Lyomeri, the fore-limbs have become detached from the cranium, and limb and pectoral arch so undeveloped as to present a condition which is attained by many fresh-water forms before they leave the egg. The Cetacea, Lyomeri and Ichthyosauria, are the only vertebrates in which the pelvic or pectoral girdle has suffered displacement, detachment or reduction, except the Physoclisti, and, while it must be admitted that our information as to how this occurred, is for the most part only inferential and based upon comparative studies of the morphology of allied forms, as far as regards the first three, the actual observation of how such a process *has* occurred in the last named group should make us all the more ready to expect equally remarkable revelations regarding the others. And of fossil groups besides the Ichthyosauria, it is not impossible or improbable that such as the Enaliosauria and others, might afford profitable and suggestive contrasts. These, however, we can have little hope of studying from the stand-point of the embryologist, owing to the paucity of material.

The embryological evidence has now been stated, together with such a discussion of the extent to which translocation of the limbs, during their early stages, has had any bearing upon the questions at issue, so that we may at once turn to the consideration of the morphology of adult forms in this connection.

2. *Anatomical evidence, considering especially the relations of the spinal nerves to the limbs.*

In order to make comparison easy between the various adult types, I have tabulated the pairs of nerves which enter into the composition of the brachial and lumbo-sacral plexuses, or, as we may name them for brevity's sake—*proplexus* and *postplexus*, in such a way as to show their inexact homology and homonymy at a glance. The pairs of nerves belonging to the proplexus are indicated by the sign *x*, while those belonging to the series of the postplexus are indicated by the sign *o*; these signs are also placed in the successive columns from left to right in such an order as to indicate at once the serial number of the nerves they stand for, as reckoned from the occipital foramen towards the end of the tail.

The relations of the proplexus and postplexus may be graphically represented by such a table and it is evident from a simple inspection and comparison of the limb-innervating series of spinal nerves indicated by the arbitary signs, that there is clearly a lack of homonymy of the paired limbs, if the determination of such homonymy depends upon the origin of the paired limbs from somites, which are distant the same number of segments from the occiput or posterior extremity of the head.

The thirty-two pairs belonging to the proplexus of *Raia eglanteria* cannot by any possible supposition be made equivalent to the third and fourth nerves entering into the proplexus of *Rana;* nor can it be shown that the proplexus of *Raia* is exactly homologous with that of *Esox* or *Cottus.* Even supposing that every two or three pairs of *Raia* represent morphologically, but a single pair in *Rana* and *Esox*, the difficulty is not disposed of, because, while it is possible to suppose that one-half of a given number of somites in a Selachian, represent a morphologically equivalent number in Teleosts or Amphibia, there is no valid ground anywhere discoverable in morphology, for supposing that the ratio of the morphological equivalency, when the values of the somites of the two types are contrasted, is greater than this. This contrast, however, does not avail, for even upon such a supposition, one-half of the number of nerve pairs in the proplexus of *Raia* is sixteen, or eleven more than in *Esox.*

The utter absurdity of this last way of bringing the proplexuses of *Raia* and *Esox* into homonymical agreement is brought out, if we make another contrast. In fact, it is possible to show that, if we push the theory of multiples too far that we cannot account for the relations of the post-plexuses of a Physostome and a Physoclist. For, suppose the thirty-two pairs of the proplexus of *Raia eglanteria*

fused by fours into eight, this brings the first pair of the post-plexus into the position of the ninth, but in the Physostomous *Esox*, the the first pair of the post-plexus is the 18th, while in some Physoclists, the first pair of the post-plexus is the fourth or fifth, a result which makes the absurdity of such a method of reasoning still more preposterous. The climax is reached when the theory of multiple equivalency is resorted to in comparing the post-plexus of *Raia* and *Esox*. The thirty-third to the forty-sixth pair in *Raia*, fourteen in all, would be equal to about three, or a little more, pairs in the post-plexus of *Esox*, on the basis of the doctrine of multiples. This is four less than the required number in *Esox*, besides which, the first pair would be brought into the position of the ninth instead of the eighthteenth, its required place. Or if we took two pairs of spinal nerves of *Raia* to equal one of *Esox*, we should only have seven for the post-plexus of the latter or one less than the required number, while the first would be brought into the position of the seventeenth instead of the eighthteenth, its required position.

The table also shows that the proplexus of *Raia batis*, according to Swan, is nearly equal to the pro-and post-plexuses of *Raia eglanteria* taken together. It is also shown that the proplexus of *Mustelus canis* is made up of not quite half as many nerve pairs as that of *Raia eglanteria*, and it therefore has just a third as many as *R. batis*. In that it is now known that each anterior somite gives off just twice as many muscular buds as there are somites, the buds corresponding to as many rays, it is clear that the anterior fins of these three Elasmobranchs are not the exact homologues of each other, that is, the pectoral of *Raia* is derived from more somites than that of *Mustelus* and they can therefore not be equivalent in an exactly homological sense.

A still further inspection of the table will enable the reader to make many other comparisons which will be equally striking. Amongst the others, that of *Phocœna* is one of the most interesting. It will be seen that the post-plexus is pushed backward. But this may be partially accounted for, as only the first five pairs can be fairly compared with those of other Mammals, this plexus in *Phocœna* as a whole, having undergone reduction, the thirty-first to the forty-fifth pairs forming what ought, perhaps, to be considered a caudal plexus.

Throughout, it will be seen that from the Amphibia onward, the number of nerve pairs entering into the formation of the plexuses, have undergone as marked and abrupt a reduction in number, as the

TABLE, SHOWING THE SEGMENTAL DISTRIBUTION OF THE NERVE PAIRS FORMING THE PROPLEXUS AND POSTPLEXUS OF VARIOUS VERTEBRATES.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Marsipobranchii, Branchiostoma, Anguilla	X	X	X	X	X																					
Cottus scorpio. (Ryder.)	X	X	X	X	O	O	O																			
Esox lucius (D'Alton)	X	X	X	X	X												O	O	O	O	O	O	O	O	
Raia eglanteria. (Ryder)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Raia batis. (Swan)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Rana esculenta. (Ecker)			X	X			O	O	O	O																
Columba domestica (D'Alton)											X	X	X	X						O	O	O	O	O	O	O
Testudo Europæa (Bojanus)						X	X	X	X	X						O	O	O	O	O	O					
Phocæna communis (Cunningham)				X	X	X	X	X	X																	O
Lepus cuniculus. (T. J. Parker)					X	X	X	X	X															O	O	O
Homo sapiens. (Gray)					X	X	X	X	X										O	O	O	O	O	O	O	O
Felis domestica. (Mivart)						X	X	X	X														O	O	O	O
Mustelus canis. (Thacher)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X											
Crocodilus acutus (Fürbringer)							X	X	X	X	X															
Uromastix spinipes (Fürbringer.)						X	X	X	X																	
Platydactylus ægypticus. (Fürbringer)					X	X	X	X	X																	
Pseudopus pallasii. (Fürbringer)				X	X	X																				
Chamæleo vulgaris. (Fürbringer.)			X	X	X	X	X																			

	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
Marsipobranchii, Branchiostoma, Anguilla																										
Cottus scorpio. (Ryder.)																										
Esox lucius (D'Alton)																										
Raia eglanteria. (Ryder)	X	X	X	X	X	X	O	O	O	O	O	O	O	O	O	O	O	O	O	O						
Raia batis. (Swan)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X							
Rana esculenta. (Ecker)																										
Columba domestica (D'Alton)																										
Testudo Europæa (Bojanus)																										
Phocæna communis (Cunningham)	O	O	O	O	■	O	O	O	O	O	O	O	O	O	O	O	O	O	O							
Lepus cuniculus. (T. J. Parker)	O	O	O																							
Homo sapiens. (Gray)	O																									
Felis domestica. (Mivart)	O	O																								
Mustelus canis. (Thacher)																										
Crocodilus acutus (Fürbringer)																										
Uromastix spinipes (Fürbringer.)																										
Platydactylus ægypticus. (Fürbringer)																										
Pseudopus pallasii. (Fürbringer)																										
Chamæleo vulgaris. (Fürbringer.)																										

radii or digits, in the transition from the many-rayed fishes. This is a very significant fact and is of striking importance, as indicating that there is a certain general correspondence between the number of nerve pairs and the number of digits in the hepta-dactyle, (=what was formerly considered the pentadactyle) limb of higher vertebrates, since the identification of extra, but vestigiary radial, ulnar, tibial and fibular digits by Bardeleben. The seven digits of the manus never much exceed the usual five, to six pairs of the proplexus, while the seven digits of the pes do not much exceed or fall below the six to nine nerve pairs of the most usual type of postplexus. We saw too, that in those cases where an excessive number of digits were developed in the fore-limb, as in the case of *Raia*, there was an exact correspondence in the number of nerve pairs of the proplexus. The exactitude of this correspondence is in fact, apparently, in proportion to the degree to which the digital elements—radii (of the pro- meso- and metapterygium) have retained their archaic composition, relation, want of torsion, etc., in either limb,

3. *Fusion of radii to form the pro- meso- and metapterygium and their inexact homology.*

On the basis of the doctrines established by Dohrn, through ontogenetic research, it is quite safe to assume with him, that the three basal elements of the limb in Elasmobranchs have been derived from the primitively separate cartilaginous radii, developed in the mesoblastic tissue between the muscular limb-buds thrown off by the somites. The different genera of Selachians, however, show that the pro- meso- and metapterygium, as suspected by Wiedersheim, are probably not exactly homologous, because the mesopterygium is not always present, and when present, upon comparing any pair of genera, it will be found that in no two do the number of radii present in the pro- meso- and metapterygium correspond. This difference is apparently due to the fact that the number of radii in the whole limb, in different genera, is not constant, as already pointed out. Furthermore, it is evident that the pro- meso- and metapterygium respectively, cannot be of the same morphological value in different genera, if the same number of somites do not take a share in the formation of each of these three parts in different genera. It follows from this that neither the uniserial nor biserial archipterygium of Gegenbaur and Huxley can be made to yield such a fixed hypothetical type as will lead up to the various modifications of the paired

limbs, because it can be shown that what is metapterygium in one case is not such in another; besides, there are embryological difficulties in the way which are insuperable. The exact homological equivalency of pro- meso- and metapterygium, has in fact, been abandoned by some of the ablest contemporary anatomists.

4. *Formation of plexuses and their inexact homology.*

There is no more reason to suppose that the nerve plexuses of vertebrates are exactly homologous, than there is for the supposition that the muscles are exactly homologous. The trapezius and latissimus dorsi for example, cannot be regarded as having exactly the same morphological value in Man, Selachians and Amphibians, because in these three cases they are not derived from the same number of somites; they are only physiologically homologous.

The arguments of Gegenbaur, Fürbringer and Davidoff that the limbs have migrated backwards or forwards, as indicated by the existence of the collector nerves formed by the ansæ and commissures between successive pairs, anterior and posterior to those pairs which form the functional plexus of the limb, are not sustained by embryological evidence, and the existence of the *nervus collector* is rather to be taken as evidence that the radii belonging to the pairs entering into the anterior and posterior portion of the *n. collector* have been suppressed or fused with the radii forming the peduncle of the limb. My reason for holding this opinion is, that the only case in which the effect of translocation of a limb on the peripheral ends of the nerve pairs passing to that limb, has been traced embryologically, shows that their peripheral ends travel with the displaced limb, at the same time retaining their origins, and do not run parallel for a long distance with the functional pairs, as is shown by Davidoff's own figures of the nerve plexus of *Acanthias*.

Whatever fibres of the collector nerve enter into the plexus of the functional limb, have been incorporated in virtue of the constriction of the limb fold posteriorly and anteriorly, as a result of which many radii which were originally attached to the sides of the body, have acquired a secondary attachment to the proximal ends of the blended radii, from which the so-called pro- meso- and metapterygium have been evolved. There can be no doubt of the fact, that in this way the limbs of primitive vertebrates first became pedunculate. It can thus be shown that the radii which are detached from the body, are not lost but simply carried farther out by the accelerated growth of the radii forming the skeleton of the peduncle of the limb. This

type of displacement of positions of a limb, cannot fairly be compared with the case of the Physoclists, in which the peduncle of the limb also shifts its position in reference to the origin of its nerve supply. The foregoing view as to the origin of the *n. collector*, has, I would state here, been arrived at independently by Wiedersheim in the second edition of his *Lehrbuch*, (p. 323).

It might also be added that, wherever the proplexus and postplexus are parts of a continuous series of pairs as in *Raia*, the fin-folds of both pairs of limbs are also continuous at the time they first grow out, whereas, when they are not continuous, and when the anterior and posterior limbs grow out as more or less widely separated folds, but with abortive limb-buds intervening, which never form a part of the permanent limb, as may be observed in the embryos of *Mustelus*, the two plexuses are separated by an interval.

Such forms as *Raia*, also exhibit extensive fusion of the proximal ends of the separate radii, leading to the formation of the longest possible type of pro- and metapterygium, whereas in the types like *Mustelus*, the propterygium and metapterygium are composed of fewer radii. They cannot, therefore, be homologous and we cannot on that account take any metapterygium or propterygium or whole fin of any particular type, as the ground form from which an ideal archipterygium or cheiropterygium may be supposed to have arisen. It is probably better for the present to assume, for the reason that an inexact homology exists when the limbs of different vertebrates are critically compared, that the different types of limbs, as we now see them in the higher groups, have arisen independently and differently in the different phyla. That the manus and pes, as seen in the various vertebrates, from Amphibians upward, show a common plan there is no doubt, but of the fact that similar structures may originate independently of each other, we have numerous instances in the animal kingdom.

It is not even certain that there may not be more than two pairs of limbs developed in certain Fishes. In the cephalic fins of *Torpedo* and *Narcine*, the radii rest upon the rostral cartilage of the cranium, thus separating them from the shoulder girdle. This attachment is supposed by Gegenbaur to be a secondary one, the radii of the cephalic fins being part of the radii of the propterygium, secondarily de-detached from the anterior portion of the pectoral. But for this opinion there do not seem to be more valid grounds, than for the supposition that the cephalic fins are outgrowths of the head, since

it is known that in some Dipnöi, the pectoral limb is innervated partly by branches from the hypoglossus and vagus, (*Protopterus*).

In the domesticated races of the Japanese Gold-fishes, popularly known as "Fan-tails," in which both the anal fin and the ventral lobe of the caudal fin are frequently double, it has been shown by Mr. S. Watase that they arise from a pair of parallel ventral fin-folds extending from the hinder part of the yolk sack to the end of the notochord. He has further shown in the same memoir* that the double, ventral series of interhæmals of the anal and caudal of these fishes are the supports of the radii derived from actinotrichia and the cartilaginous nodules at their bases, thus bringing these fins into complete morphological harmony with the ventrals, in which the pelvic girdle is probably to be considered as representing modified interhæmals. It indubitably follows from this, that the double or paired anal and the double inferior lobe of the caudal, are to be considered as paired fins or limbs serially homologous with the pectoral and pelvic pairs. While this embryological and morphological evidence most admirably confirms the views of Dohrn as to the nature of the paired limbs, there can be little doubt that, the double anal and caudal have a just claim to be regarded as additional pairs of limbs, making four pairs in all. Their development is further to be regarded as due to reversion induced by a process of degeneration, which has affected the whole urosome or tail of these fishes from the vent backwards. This degeneration seems to be due to domestication, since it is now admitted by an expert American breeder of these varieties of gold-fishes, Mr. W. P. Seal, that the forms most modified and prized by fanciers can only be reared in restricted quarters or in aquaria or protected pools of moderate dimensions. The extreme shortening and modification of the muscular and axial parts of the tail, has been produced in the course of a prolonged process of selective breeding, their singular changes of form being probably due to disuse. The most modified forms which the writer has seen alive, were slow and sluggish in their movements, their enormously lengthened caudal, pectoral and ventral rays and membranes seeming to interfere with any rapid motions. The shortening of the muscular portion of the tail would also aid to produce such a result, as is known from Strasser's experimental researches on the function of the tail in fishes.

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*On the caudal and anal fins of Gold-fishes. Journ. Science College, Imperial University, Japan. Vol. I.

The degenerative processes made manifest in ontogeny, often undo the synthetic or constructive morphological work, which has been accomplished during phylogeny. This seems to be the case in these extremely modified forms of Gold-fishes, in which, indeed, there is palpable evidence of great cranial modification, similar to that seen in domesticated races of Pigs and in the Japanese Lap-Dogs (*Dysodus*, Cope), in all of which, as in these fishes, the anterior cranial and facial bones have been greatly modified.

The preceding explanation seemed necessary in order to emphasize the doctrine that paired fins might be evolved from the sides of the tail as supposed by Dohrn and Mayer, by the median fusion of the ventral fin-folds, which, according to their views, were primordially double and lateral. It follows from this doctrine, that the nerves passing to the musculature of the anal and caudal pairs of fins, must be considered as forming two additional plexuses, neither of which can by any mode of torturing the facts, be rendered homologous with those which supply the pectoral or ventral pairs.

III. Consequences of the preceding data.

The facts presented above seem to me to lead to the conclusion that the ichthyopterygium in Fishes is very far from representing the same or homologous structure; a view which the ontogeny of the higher vertebrates fully confirms. While the first point has been admitted by Mivart, Huxley and others, the second has not received the attention which its importance demands. The fact that the rudiments of the paired limbs do not normally arise in a homonymous position or at the same points along the axis in Mammals, Birds, Reptiles, Amphibia, etc., and without any manifest action of translocation during development, seems to the writer to preclude the possibility of our assuming that there has existed a common and exactly homologous, ancestral chiropterygium, from which the limbs of vertebrates, from Amphibians upward, have been evolved. There are many difficulties in the way of an answer to this question. First of all, the universally admitted fact that similar structures may be developed under similar conditions in widely dissimilar types. Secondly, the utter want of exact homology when the pro- meso- and metapterygium are compared. Thirdly, the few unassailable facts which we possess in regard to undoubted instances of the translocation of limb rudiments. Fourthly, the origin, by coalescence, of an indefinite number of radii to form the pro- meso- and metapterygium. Fifthly, the variations to which this coalescence is subject; that is,

posterior radii may be swept forward proximally or anterior ones may be swept backward proximally; or both processes may occur simultaneously; or certain radii may be so accelerated in their growth and others so retarded as to give rise to a uniserial or biserial pedunculate limb. Sixthly, the evidence as to occurrence of the abortion and extensive loss of radii in any part of the ichthyopterygium is clear, as well as the frequent dichotomous subdivision of the distal ends of single radii* as in the pectorals of *Raia*, and cephalic fins of *Torpedo*. Such secondary or divided radii may indeed be homologous with the digits of higher forms, as it seems might be countenanced by the fact that the limbs of some Amphibia have but two digits at first, and that the others afterwards bud out at one side or edge as was first noted by Prof. Baird, and subsequently confirmed by Cope and Baur. Such a view is also to some degree countenanced by the manner in which supernumerary digits develop in Amphibia and by the simple structure and variability of the manus and pes of *Amphiuma* or *Muraenopsis*. Seventhly, the obviously compound nature of the mesopterygium of *Polypterus* as is proved by the presence of serially or segmentally arranged foramina, perforating it for the passage of nerves, and which has been supposed to be shoved outward to give rise to the intermedium, which in the chiropterygium, must accordingly represent twelve fused radii, whereas, it ought not at most, represent more than three or four. Eighthly, the lack of correspondence or agreement in the structure of the tarsi and carpi of higher forms, some of which are believed to present traces of not less than six digits; and in others as many as seven, and the impossibility of determining with absolute certainty, the homologues of the tarsal and carpal bones, as the *centrale* is sometimes represented by two elements or is so obscured as to be too indistinct to be clearly made out; the same may be said of the *intermedium*. Ninthly, the impossibility of determining from which border of the primitive fold the elision or abortion of radii first began, owing to the fact that the torsion of the fold on its own base, does not always appear to occur or at least is not recapitulated, this torsion varies from 90° to nothing at all. Whether the suppression of radii was metapterygial or propterygial at first, we cannot now determine with certainty, and all that we can justly say is, that it has probably occurred on both borders in various types, and to the extent of a

*The radii of Elasmobranchs as here understood are in no sense the homologues of the rays of Teleosts, which are mainly derived from actinotrichia.

variable number of radii in different cases. Tenthly, if the digits of higher forms represent the distal extremities of one or two dichotomously divided single rays, each derived from a single somite, it is not possible to state with certainty to which order of secondary branches they belong, because the epiphyses and diaphyses of the proximal long bones may represent elements which should be taken into account. The digits would probably represent the second subdivision, if the epiphyses of the long bones were thrown out of the reckoning.

The following suggestion seems very important. The manifest impossibility of deriving a chiropterygium from a given or known uniserial or biserial ichthyopterygium, which will serve as a starting point for the limbs of all known higher vertebrates, forcibly impresses the conclusion that, firstly, the limbs of all vertebrates are not necessarily exactly homologous and that, secondly, the chiropterygium has in all probability been independently developed several times and indirectly from different segments along the sides of the primitive vertebrate body.

The importance of this conclusion, as qualifying the prevalent doctrines regarding the homologies of the limbs of vertebrates, may be inferred since it has been found by Albertina Carlson (Kongl, Svensk. Vet. Akad. Handl. xi, 1887,) that in the Ophidia the postplexus may be developed opposite the intervals between the 275th, to the 278th, vertebræ. Besides this, Miss Carlson has shown that there is great variation in the position of the postplexus in different genera of Ophidians.

It seems almost unnecessary to note here, that the modifications of the position of the limb in reference to the same segments along the body, also implicates the homologies of the muscles and blood vascular supply.

The view which has been suggested above as to the origin of the limbs of the higher vertebrates, implies that the distinction between the uniserial and biserial archipterygium is simply formal; that whether a fin shall become provided with series of radii on one or both sides depends on the manner in which coalescence of the primary radii took place; whether, in fact, from one or both borders. The usual type in Elasmobranchs occurred by coalescence from behind. In *Raia* coalescence occurred from both the anterior and posterior borders of the pectoral as shown by its ontogeny, giving rise

to a uniserial (anterior) propterygium, and a similar (posterior) metapterygium.

The cause of such coalescence has been in part, that other adjacent functionally active parts pressed upon the radii which were growing at an accelerated rate. The mode in which the radii composing the fins were functional was also active in promoting coalescence, in fact, there is no reason to doubt that almost exactly the same arrangement of forces was potent in inducing the displacement forward of the proximal ends of the posterior radii of the pectoral and pelvic fins, as in the case of the caudal, as the writer has attempted to show in his essay on the origin of heterocercy. This is also strikingly shown in the dorsal and anal fins of some species. The increased pressure or resistance exerted by the surrounding water on the hinder lower quarter of the vertical or lateral fins while in action would constantly tend, owing to the peculiar flexures assumed by the surfaces of the fins while in motion, to shove the hinder border forwards and carry the basal ends of the hinder radii forwards. The method of this might be shown by means of a diagram, in which the force exerted by the fin was one side and the resistence of the water the other side of a parallelogram of forces, while the direction in which the base of the fin was constantly tending to be displaced, would be determined by the resultant acting against the hinder lower margin of the fin. The alternating direction of the stroke of the fin does not impair the efficiency of this set of active forces, but makes them more efficient, since, though the action of the forces is alternately reversed as respects the directions in which they act, the effect is the same.

This hypothesis of the origin of the uniserial fin applies to all its types, whether encountered in the dorsal finlets of *Polypterus* or in the paired fins of Elasmobranchs, Chondrosteans and Chimæroids. It also leads up to a more comprehensive theory of the origin of all the modifications of the fins, as seen in the diverse types of fishes.

As to the chiropterygium, we are warranted in the affirmation that, whether it has arisen from the dichotomous division of the distal portion of a separate and single ray, or of two rays, or by the modification of the distal radii of a uniserial metapterygium, or of the distal end of a biserial metapterygium, our difficulties are pretty much the same. And, while the view that those limbs which seem to show traces of the plan of the chiropterygium, have probably arisen from some type approximating the metapterygium of some Elasmobranchs, we must admit that we cannot, for lack of evidence,

specify the particular type of metapterygium and over what particular somites it was primarily attached, nor even, indeed, that particular radii, with terminal dichotomous divisions, may not have been equally well adapted to furnish the morphological foundation of the chiropterygium and the endless variety of terminal modifications of the fore-and-hind-limbs of the higher vertebrates.

PROLONGED LIFE OF INVERTEBRATES: NOTES ON THE AGE AND HABITS OF THE AMERICAN TARANTULA.

BY HENRY C. MCCOOK, D. D.

Until very lately little has been known concerning the possibilities of prolonged life among the lower orders of animals. It is well known that the waste of life is very great in the natural conditions surrounding most inferior creatures, so that the immense fecundity of insects and araneads, for example, is abundantly checked. I have counted over eleven hundred eggs and young spiders in the single egg-cocoon of the Bank Argiope, *Argiope riparia,* yet one of the rarest finds for an observer is a very young individual of this common species. In efforts to breed spiders from the cocoon, I have at various times seen colonies numbering one hundred or more dispersed from the maternal egg nest to the surrounding foliage, of which during the year not a single survivor could be traced.

Bee keepers are well aware of the great mortality among working bees, caused not only by disease and accidents, but especially by those enemies which prey upon them. Ants are quite as much, perhaps even more exposed to loss from accidents, the exigencies of weather and the appetites of various insectivorous animals. There is, therefore, abundant occasion for the seemingly exhaustless fertility of the queen mothers of formicaries. These queens probably have a longer life than the workers. They are larger in size and apparently organized for more vigorous resistance of the influences which work for their destruction. Moreover, the instinct of the workers has provided a system of preservation by surrounding the queen with a guard of attendants which never leave her unprotected, which care for all her wants, and vigilantly separate her by a regular system of seclusion within the portals of the formicary, from many influences which would prove hostile to health and fatal to life.

I. SIR JOHN LUBBOCK'S AGED ANT QUEEN.

How long an ant queen may live in entirely natural habitat is unknown, and perhaps cannot be determined. But recently through the patience and ingenuity of Sir John Lubbock, we have learned that under artificial protection both workers and queens of certain species may attain a great age. Nearly six years ago I had the privilege of visiting this distinguished naturalist at his country seat, High Elms, Kent, and examining, under his personal direction, his

artificial formicaries and the mode in which they are preserved. At that time I saw a queen of the Fuscous ant, *Formica fusca*, which was nearly eight years old. During the past summer (1887) I again visited Sir John at his house in London, and on inquiry after the aged queen, which I supposed to be still living, was informed that it had died the day before, having at the time reached the wonderful age of more than thirteen years. I was permitted to see this venerable queen as she lay in death on the floor of one of the wide chambers which the workers had excavated in the soil compacted between glass plates that bounded their formicary. She was still attended by the circle of "courtiers," which, according to my published observations,[1] are in the habit of waiting continually upon ant queens. Some of these attendants I saw licking the dead queen, or touching her with their antennæ and making other demonstrations as though soliciting her attention or desiring to wake her out of sleep. "They do not appear to have discovered that she is really dead," remarked Sir John. And so indeed it seemed. It was certainly a touching sight to witness these faithful attendants surrounding the dead body of one who had so long presided over the maternal destinies of the colony, and seeking by their caresses to evoke the attention which never again could respond to their solicitations.[2]

Such experiments as the above clearly indicate that artificial environment may have a beneficial influence upon insects as well as domestic animals, and that the interference of human intelligence may be a preservative factor as well as a destructive one in the lives of even our most lowly organized fellow creatures.

While awaiting with great interest the details of the life history of this venerable sovereign of the emmet world, which Sir John Lubbock will doubtless publish, I venture to note the simple fact of her prolonged life as an introduction to some facts in the same line of observation, but relating to a spider.

II. Long Life of a Spider.

Early in the year 1872, I received from Dr. Joseph Leidy a specimen of our common American species of the Theraphosoidæ, first described and known as *Mygale Hentzii*, and popularly called the tarantula. This animal was given to Prof. Leidy by a young friend and turned over to me with the request that at its death the specimen

1 "Honey and Occident Ants" Chap. iv, p. 41 and Pl. VI, fig. 29.

2 See note at end of paper.

should be returned to him.[1] As the individual seemed to be in good health, I preserved its life in order to gain information as to its habits and vital endurance. It was first placed in a large glass fish globe on a bed of earth, where it was kept for more than a year. It was then transferred to a wooden box made with glazed slides and a sliding glass door at the top, the whole being eighteen inches long, twelve inches wide and ten high. One end was filled with dry soil which was slightly compacted and heaped up; the other end was sparsely covered with earth. There was thus presented a bit of level space for a water trough, for exercise etc., and full opportunity for the spider to burrow should it be inclined to its natural tastes. The animal was kept in this box until mid-summer of the present year. I last saw it early in July, just prior to my departure for England. On June 22nd, 1887, I made this note: "This spider which has been kept ever since 1882 is to-day in good health. It is on the outside of the earth moundlet in its box looking hearty after the winter's fast. It has had nothing to eat since October last—at least eight months, but has had water freely. Some flies have been put into it lately, but I do not know that they have been eaten." The spider was then left in the care of my friend, Professor Fronani, who for several summers, while at work in the Library hall of the Academy, had kindly cared for it during my absence, giving it water and feeding it with insects, particularly grass-hoppers, or locusts.

On my return from abroad I was met at the Academy by the intelligence that my tarantula was dead. It had descended into the burrow, which for several years it had maintained close to the side of the box, about the end of July, and since then had not come up. Looking into the box I could see against the glass what appeared to be the fragments of the moulted skin on one side of the cavity, and on the other side the outlines of the creature's dead body. Prof. Leidy, from whom the animal had been received, and after whom I had named it, (a name being convenient for familiar reference,) happened to be in the Library hall at the time I took up the remains of the spider from its burrow. We found the carcass already partly decomposed and being preyed upon by dermestid larvae. Close beside it were the fragments of its cast skin. It had evidently died shortly after moulting.

[1] It was captured about the beginning of April 1882, at Hill's Ferry, Stanislaus Co., California, was kept in a bottle without food for two weeks, then sent to Prof. G. E. H. Weaver at Media, then a student in Swarthmore College. Mr. Weaver fed it on beefsteak which it took readily.

Reckoning its death as having occurred at the close of July 1887, the spider was five years and three months in my possession. I have not sufficient data to estimate accurately the rapidity of growth in this species, but judging from such facts and indications as I have observed, I do not hesitate to reckon the animal to have been from eighteen months to two years old when I received it from Dr. Leidy. At the period of its death, therefore, it must have been at least seven years old, and may have been eight. It has thus attained the distinction of having reached the greatest age of any spider known to science. How long this species and members of the Theraphosoidæ generally live in their natural habitat is of course unknown. I have no doubt that they live much longer than spiders of the other great sections or groups, but am inclined to think that it is not usual for them to reach such on age as my tarantula "Leidy." In its case, as in that of Sir John Lubbock's queen ant, human protection probably aided to prolong life.

Such observations as have heretofore been made upon the age of spiders fall in with the general indications as to their vital endurance made by the prolonged age of this tarantula. Blackwall, the veteran British araneologist, kept spiders of the species *Tegenaria domestica* and *T. civilis* to the age of four years.[1] Moggridge made a calculation upon the age of trap-door spiders based upon the average growth in the nests of the young, for he established the fact which has subsequently been confirmed that the young spider instead of abandoning its nest enlarges it with its growth. The conclusion of this calculation was that it took at least four years to produce a full size trap-door nest, and of consequence the architect must be at least that old.[2] The most recent information upon this point is given by Mr. Fredrick Enock in a paper published two years ago.[3] This observer in an extended and interesting communication upon the habits of the British Atypus speaks of one individual which he had in his possession over three years, and which, judging from its size when first captured, he puts at the age of six years. Other examples which had been under observation for more than two years were well grown when first transferred to his artificial colony,

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[1] "Spiders of Great Britian an l Ireland." p. 8.

[2] Moggridge. "Harvesting Ants and Trap-door Spiders." p. 127.

[3] "The Life-History of *Atypus piceus*, Sulz." Transactions Entomological Society of London. 1885. p. 416.

and at the date of his paper, June 1885, were still in good health. He ventures the inference that *Atypus* is about four years in reaching maturity, then retains her young for eighteen months under her care before turning them out to shift for themselves, and after that lives in vigorous health for a period which he believes may sometimes reach the advanced age of ten years.

I may add here, as in the same line of research, that Dr. George H. Horn a distinguished authority in the Coleoptera, has called my attention to the fact that a female of *Cybister roeselii* was preserved for eight years of continuous life by Dr. David Sharp.

As has been stated, my tarantula died in the act of or in consequence of casting its skin. It has usually been accepted as a fact that the final moult of spiders is made just before the attainment of maturity. Unfortunately the decayed condition of the carcass does not permit me to determine the question in the case of this particular individual. But these interesting queries are suggested: did the artificial conditions of the spider's life so influence its organism as to retard the functions that result in the act of moulting? Are we therefore to consider this final moult, accomplished at the age of seven years or thereabouts, to have been abnormal as to the time of its occurrence? Or, may we infer that this represents the normal periodicity of moulting and of consequence that the mature spiders of this family, which are so frequently taken in various parts of the earth, are all of them as old as the one whose history I have been noting?

III. Habits of the American Tarantula.

1. *Moulting and its dangers.*—During its confinement "Leidy" shed its skin several times. The first moult occurred sometime in August 1882. I had been absent on my usual summer vacation and returning August 31st, saw the animal lying on the soil about the middle of its glass nest with its feet gathered together looking dull, gray and faded out—apparently dead. I shook the globe. No response was made by any action, and as I was at the time in a great hurry, I left without more careful observation, concluding that the spider was dead. I was not able to visit it again until the fifth day of September following. I threw off the cover of the globe and put my hand in to take out the dead body, which lay apparently in the same position, in order to preserve it in alcohol. As I touched it the animal leaped to its feet, and as I hastily withdrew my hand thankful for the danger which I had escaped, for the creature bears

a poisonous fang, it presented itself quite changed in appearance. The body was of a fresh, bright color, the cophal thorax a clean whitish gray, the head and fangs dark brown. The abdomen was black with brown hairs covering it. The legs were black with yellowish brown hairs and spines. I at once understood that the spider when first seen was in the torpid condition which usually immediately precedes the act of moulting. In the interval between my visits it had cast off its skin which I found lying in a tolerably complete condition on one side of the glass. The spinnerets and abdomen were entirely unbroken, the spider having evidently escaped therefrom by pulling its abdomen forward. (Fig. 1).

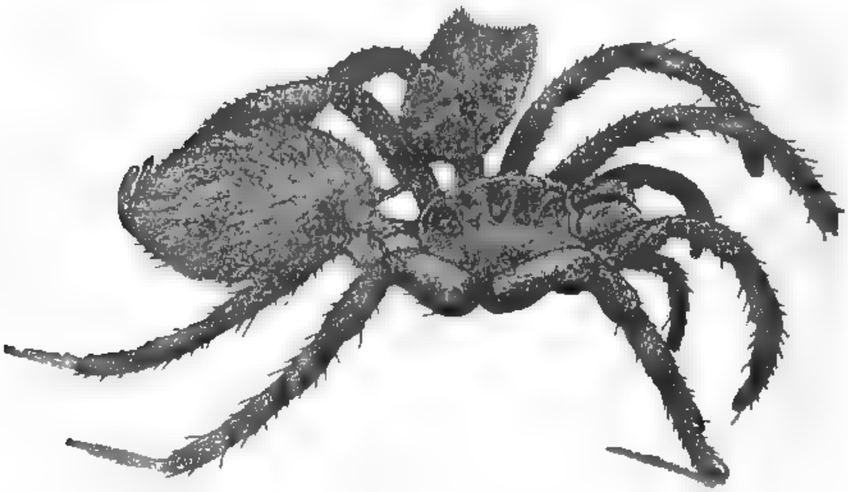

Fig. 1. Moult of Tarantula showing mode of Escape.

The dorsum of the cephalthorax was attached to the upper part of the abdomen, and the sternum to the lower part, showing that the fore part of the skin had cracked around the median line of the cephalthorax. The feet and legs were attached to the sternum, and on one side the casts were entirely complete.

The death of this tarantula is another example of a fact which I have previously observed, that the act of moulting is frequently attended by dangers of one kind or another to spiders. It is common to find specimens without one or more limbs, also with distorted and abbreviated limbs. I have frequently found males lacking several legs. The theory commonly adopted is that in most of these cases the loss has resulted from conflicts, perhaps among rival lovers in

attendance upon the same female. Something of loss may be attributed to this cause, but I am satisfied that in a much larger degree losses and malformations are due to the accidents of moulting. One example I may cite, the loss of two limbs experienced by a large tarantula which I had kept under observation; for during the last few years I have had a number of these large creatures in artificial nests. This spider lay upon its back during part and on its side during the remainder of the time of moulting. The skin was cast by a succession of movements of the body or parts of the body recurring at regular intervals reminding one of labor pains among mammals. For some reason two of the legs refused to separate from the skin and after a prolonged struggle they were broken off at the coxae, and remained within the moult. One foot of another leg shared the same fate. This moult occurred in the spring; during the latter aprt of August of the same year the spider again moulted. The moult was a perfect cast of the animal, the skin, spines, claws and the most delicate hairs all showing, and their corresponding originals appeared bright and clean upon the spider. When the cast off skin was removed the dissevered members were lacking thereon, but on the spider itself new limbs had appeared, perfect in shape but smaller than the corresponding ones on the opposite side of the body. The dissevered foot was also restored. The rudimentary legs had evidently been folded up within the coxae, and appeared at once after the moult, rapidly filling out in a manner perhaps somewhat analogous to the expansion of wings in insects after emerging.[1]

It is possible that my tarantula "Leidy" was too much exhausted by long previous fasting to endure the severe strain which evidently is laid upon the organism in the act of moulting, although judging from the disjecta membra of the skin recovered from the burrow it had succeeded in casting them all off without any mutilation. The Spring of 1887 was a backward one, and I experienced great difficulty in procuring insects for food from the immediate neighborhood. The annual supply of grass-hoppers and locusts upon which I had relied came very late. Perhaps had the spider been strengthened by a few week's generous feeding previous to its last moult, it might still have been alive.

2. *How to keep spiders alive.*—I may say here that my experience in keeping other large spiders is that there is quite as much danger from over-feeding as under-feeding. I have found the best success

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[1] See Proceedings Academy of Natural Sciences Philadelphia, 1883. p. 196.

by giving a generous supply of living food during the summer and early autumn, and withholding food almost entirely during the remainder of the year. I was particular, however, to keep a vessel continually supplied with fresh water within the box. Spiders require water quite as much as other animals, and failure to keep them supplied will be fatal to health and life. I have sometimes succeeded in tempting a tarantula to suck the juice of a bit of raw beef, but the only food that can be relied upon is living insects; and the spiders appear to be able to lay up within the four or five months of summer enough nourishment, in connection with a free supply of water, to last them during the entire year. They do not become torpid in the winter time, it should be said, but remain active throughout the entire season, provided they are kept in a room heated to a moderate temperature. If exposed to severe cold they are soon benumbed, but quickly recover when again brought into a warm atmosphere.

When the spider was disposed to feed, an insect was seized with the fore legs, palps and mandibles, which rapidly conveyed it to the mouth against which it was held by the palps which also turned the carcass as the spider had occasion, aided by the mandibles, the latter crushing the victim meanwhile. (Fig. 2). On one occasion

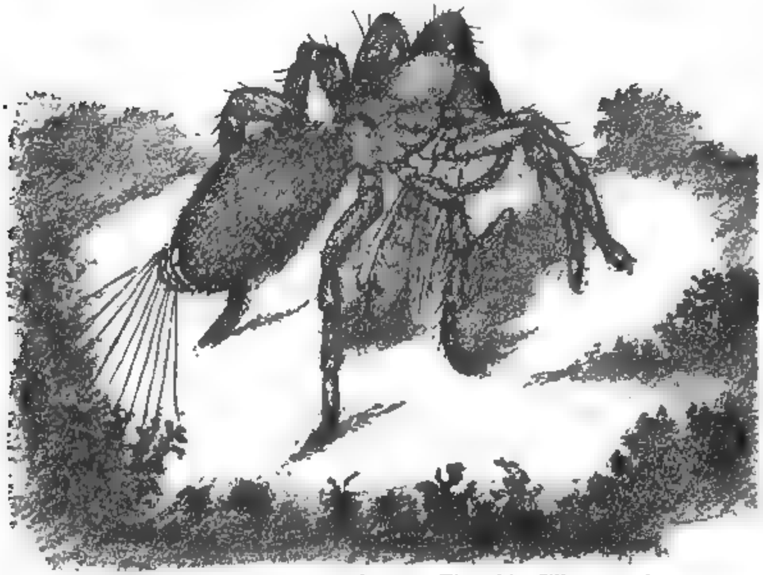

Fig. 2. Tarantula feeding upon a locust.—The white Silken rug shown.

while in the act of feeding upon a locust a second individual approcached near enough to be seized It was put upon the ground where it was held down until the spider, moving slowly around, overspun and swathed it, evidently reserving it for future use.

3. *Spinning and Spinning work.*—The central space of the little mound in the box was usually kept covered with a white sheeted web, suggesting the idea of a rug, upon which the creature loved to rest. If this were removed or covered over with dirt it was restored by the spider in a little while. In the act of spinning, the long inferior spinnerets were curved upward, and from the spinning tubes along the exterior part gave out numerous fine threads. These were attached to the ground by the downward motion of the spinnerets. The abdomen was lifted up, the threads were thus drawn out, the downward motion repeated, and simultaneously the end of the abdomen with the spinnerets attached received a lateral motion which caused the threads to be spread over the surface of the ground. At the same time the animal slowly moved its whole body around as upon a pivot, thus dispersing the silk over a circular patch of the surface, about equal in diameter to twice the length of its body, or to the spread of its legs. (See Fig. 2). At times a web much more open in texture would be found spread more or less freely over nearly the whole surface of the soil.

It has been said that when the white central rug became soiled by dirt or food debris it was soon over spread with a clean layer. In course of time the top of the mound in "Leidy's" box became thus covered with a thick mass of intermingled silk and clay which I easily removed and have preserved intact. The piece represents nearly the compass of the central rug, and is a curious compound of intermingled soil and silk. It is a fact that the remarkable hinged door which the trap-door spider attaches to her burrow is made up of alternate layers of silk and soil. If one were inclined to speculation, or to a "scientific use of the imagination," he might raise the inquiry: may not the the trap-doors spiders have found in some such accidentally formed texture the original suggestion of her mud-and-silk door? On the other hand, one might also wonder why the tarantula and, in fact, other spiders with equal facilities of like nature have not developed some trace of the same habit?

Two locusts were once placed in the box at a part where the threads were numerous, one of which was soon entangled in the spinning work and began to struggle for freedom. Tarantula was

on the mound about ten inches distant and moved slowly towards the insect, creeping, crouching, evidently directed by the agitated web. It was very tardy in its approach and my attention was unavoidably diverted, but shortly afterward I saw the spider devouring the locust. The question was raised, does the tarantula in natural site take its prey in this way, by lines spread before its den or elsewhere upon the surface of the ground? Mr. Bates appears to have the opinion that the web of the large Brazilian tarantula is used to capture prey; at least, he speaks of birds entangled therein and fed upon by the spider.[1]

The thick texture of the sheeted web is produced by the act of beating downward with the long spinnerets, repeated motions of which up and down make little loops which thicken over the surface and are beaten down and then smoothed over by the spinnerets. (Fig. 3.) The action does not greatly differ from that of all other

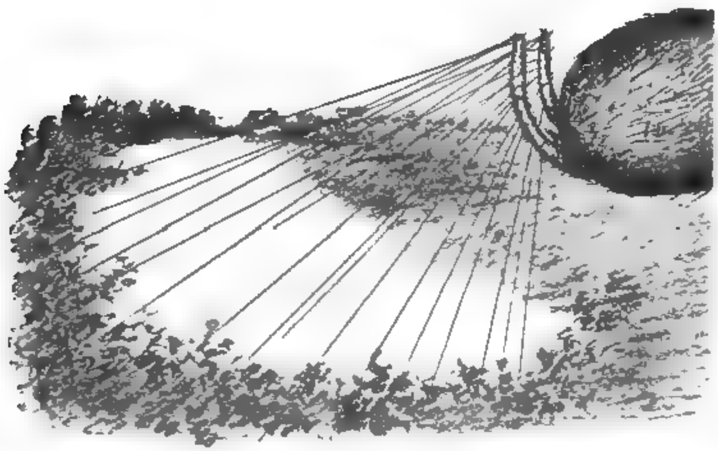

Fig. 3. Spinning the rug; use of the long spinnerets.

spiders while engaged upon similar spinning work. In the act of spinning, tarantula frequently reaches one hind claw to the spinnerets and makes a series of rapid strokes, then stretches out the foot as though carrying the thread with it. It would appear to be intended thus to draw out the silk from the spinning tubes, but the motion was so rapid that I never could exactly make out its full purpose or determine whether it might not be a mode of clearing

[1] The Naturalist on the Amazon, ii, p. 58.

out or rearranging the spinning tubes and surrounding spines; in other words, the adjustment of the spinning machinery.

4. *Character of the Nest and mode of burrowing.*—The opinion prevails largely that the tarantula, *Mygale Hentzii*, makes a trap-door nest, and it has not been an uncommon thing for me to meet tourists who had purchased in California specimens of trap-door nests, and at the same time a specimen of the large tarantula which the sellers claimed had made it.[1]

I am satisfied by my long continued observations of these creatures in confinement, as well as by authentic reports from various persons, that they make no trap-door, and that their only nest is a burrow in the ground. Dr. J. Rowland, of Media, Pa., who has several times visited Los Angelos, informs me that the tarantula is there found in holes covered with a slight web. A little mound of fresh earth is thrown up around the surface edge of the hole which is merely covered over by a delicate web. There is no trap-door to this den, which is a burrow about an inch and a quarter in diameter extending downward from ten to twenty inches in depth. The boys bring the spiders up by pouring water down the holes. The great creatures burst out of the open gate, spread their long legs and hurry away, and are then easily captured. According to Mr. G. W. Holstein who has frequently observed them in Texas they live in holes about one and an eighth inch in diameter which appear to have a white silky lining and are generally found in sandy soil. One burrow dug up by his brother was ten inches deep; was destitute of a lining, but at the bottom there appeared some sort of a nest. When disturbed the creatures run into holes formed by the weathering out of fossils &c. At Los Angelos the animals are found at times occupying gopher holes.

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[1] Professor Spencer F. Baird, the late distinguished and lamented Secretary of the Smithsonian Institution, entertained this opinion, and when I once questioned it, thought he had specimens in the museum at Washington that would prove it. He subsequently wrote me: "I did not find in any of the California nests any remains of spiders at all but we have two from Jamaica which still have large hairy spiders in them. These nests are much more slender than those from California. I shall be pleased to show them to you whenever you visit Washington. I cannot send them as they are too fragile for transmission." I have not yet had the opportunity of examining these specimens, but think that they will be found to belong to the genus *Nemesia* or *Ctenisa*, and are not true tarantulas.

Mr. Bates describes spiders of this family (*Mygale Blondii* and *M. avicularia*) as inhabiting broad tubular galleries smoothly lined with silken webs. The galleries are two inches in diameter and run in a slanting direction about two feet.[1] Again he speaks of them as spreading a thick web beneath a deep crevice in trees, and having their cells under stones.[2] Once more in alluding to their diversified habits he says that some species construct among the tiles or thatch of houses dens of closely woven web which in texture very much resembles fine muslin. From these domiciles they invade the house apartments. Others, according to Mr. Bates build similar nests in trees.[3] I believe that it will be found that the creatures that burrow in the earth are identical with those which spread sheeted webs among the trees. Numbers of tarantulas come to our port (Philadelphia) in fruit vessels, and are often found in the great pendants of bananas, to which they had no doubt resorted as a convenient field for capturing prey, and were themselves captured and shipped hidden away among the clusters of fruit.

In the case of the spider "Leidy" the only effort made at nest building was a rude burrow which was excavated against one side of the box and which in the course of time was extended downward to the bottom of the box and laterally along the bottom either way, thus forming an irregular cavity. Into this it frequently descended, dividing its time between the cave and the outside surface. This burrow was entirely destitute of a silken lining, although occasionally the opening at the surface would be overspun with a thin sheet of spinning work. I have seen the same habit in other individuals of the species kept in confinement. The only attempt at a nest ever observed by me has been this burrow, with an occasional sheeted closure, and rarely a slight silken lining of the interior of the burrow. I believe, therefore, that the popular theory that the tarantula makes a trap-door is without foundation in fact, and that its ordinary habitat is a plain burrow like that made by most Lycosids.

The mode of making the burrow was well observed by me at various times. In the act of digging, the spider first uses the two leg-like palps, the digital brushes of which are well adapted for that

1 Bates "The Naturalist on the Amazon" Vol. ii, p. 58.

2 id. Vol. i, p. 161.

3 id. Vol. i, p. 106.

service. Then the two front feet are brought into play to gather up the loose pellets of soil and scrape them into a ball. The first and

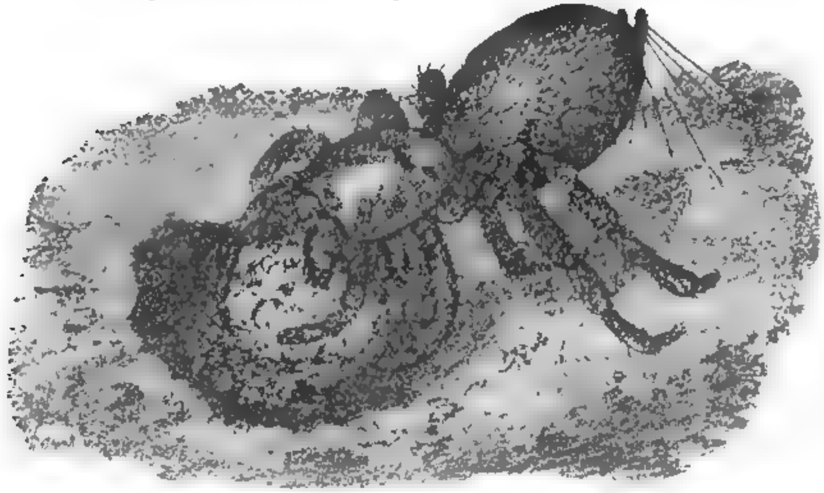

Fig. 4. Tarantula digging up and gathering a ball of earth to carry away.

second pairs of legs now close up around and under the balled mass, thus compressing it inside the mandibles. (Fig. 4.) When the pellets have thus been gathered and squeezed into a mass, they are held within the extended mandibles, the palps in the meantime girdling them at the side and beneath, and so are carried away from the burrow to the dumping ground. (Fig. 5.)

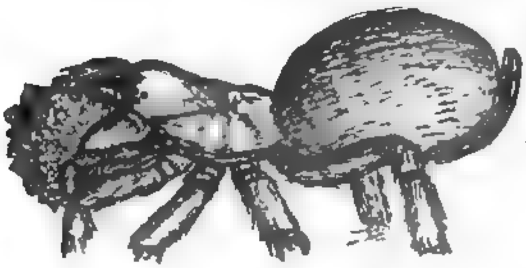

Fig. 5. Mode of carrying excavated soil.

I never observed any scratching and scraping the dirt backward in the fashion of a dog digging in a rabbit burrow, which is also the action of ants, bees and wasps when excavating the earth. Always the pellets were deliberately loosened as I have indicated, squeezed together into a ball and carried off. During the act of digging, and indeed quite habitually during all actions such as eating etc., the

spider kept her spinnerets curved over the end of the abdomen with a diverging ray of threads issuing therefrom and attached to the surface beneath.

5. *Toilet Habits.*—After digging, the palps were used to wipe off the fore parts of the body, very much as a cat uses her paw for a like purpose. The fore legs were placed against the palps and were cleansed by rubbing the two together. The toilet was also accomplished by overlapping one leg with the other, the second leg over the third, for example, and then rubbing the two as if a man were to scratch his leg by drawing the inner surface of one along the front surface of the other. The first leg was thus rubbed against the second, of course being pressed down upon it meanwhile. The palp too was thrown back to the first leg which it brushed off in the same manner. After digging in its burrow, "Leidy" was always quite sure to cleanse its person, and by reason of its size the use of its palps in wiping off the fore part of its body presented a most amusing likeness to the familiar action of pussy when washing off her face with her paws.

6. *The character of the egg cocoon.*—A large female tarantula was sent to me from the West Indies, and arrived at the Academy during a prolonged absence. She died before my return and was preserved

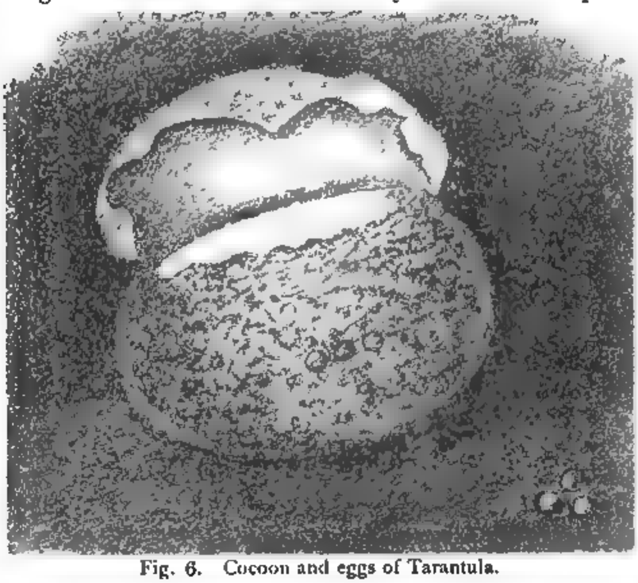

Fig. 6. Cocoon and eggs of Tarantula.

in spirits; but afforded me an opportunity, which I had long desired,

of determining the egg cocoon made by this family, the Theraphosoidæ. While cleaning out the box in which she had been sent I observed a piece of spinning work within, which proved to be an abandoned cocoon. It was much flattened, but when inflated showed a hollow spheroid composed of thick silken cloth, somewhat soiled on the outside, but within clean and white. It measured two inches along the longer axis and 1¼ inch along the shorter one. It was empty of young, whose first moults, however, were within the cocoon, as were also a few unhatched eggs which are yellowish spheres, two millimeters in diameter. Three small openings in the case showed where the spiderlings had escaped. Both cocoon and eggs are shown natural size in the accompanying figure. (Fig. 6).

The interior of this cocoon was without any flossy lining or padding, resembling thus the egg sacs of the Lycosoidæ generally. A curious flap overlapped the cocoon at one side, whose use I could not conjecture, unless it may have served to attach the object to the mother's body; or, perhaps, it was simply a remnant of material which had remained after the eggs were rolled up within the silken rug upon which they are probably deposited after the manner which I have shown to exist in the genus *Lycosa*.[1]

The janitor who received the box containing this spider and placed it in my room was at the time new in his position and did not understand the importance of observing all the particulars in the habits of living creatures sent to the Academy. He therefore failed to make any notes, but told me when questioned that he believed that the cocoon was attached to the lower part of the body of the spider when it arrived. No doubt this is a correct observation, and we may assume with some degree of certainty that the large egg sac of the Theraphosids is carried by the mother lashed to the spinnerets at the apex of the abdomen, precisely as in the case of Lycosids, whose well known habit is familiar to every frequenter of our fields.

This cocoon is exhibited in my collection of Aranead architecture deposited in the Academy, and is the only one, so far as I have been able to learn, exhibited in any similar institution. Termeyer speaks of cocoons of the Mygalidæ of South America ("*Aranea avicularia*") even greater than the above. They are three inches long by one

[1] See Proceedings Academy Natural Sciences of Philadelphia, 1884. Page 138, my note on "How Lycosa Fabricates Her Round Cocoon".

wide, and are placed in the fissures on the trunks of trees. They contain thousands of eggs. This extraordinary size of the cocoon had made the inhabitants who do not observe carefully, imagine that this spider would take the cocoon of "the bombice moth, del Guyavo (*Janus*, Linn.)" and having destroyed or eaten the chrysalis would place her own eggs therein, and then artificially close the hole by which she had penetrated it. One of these cocoons weighs as much as six cocoons of the silk worm when they are washed, and as much as three or four after having been washed.[1]

Madam Merian, who first recorded a report that the Theraphosoidæ prey upon small birds, must have observed the cocoon of these spiders, as it seems to me. She indeed speaks of them as having their domicile in a large round nest resembling the cocoon of a caterpillar, but the plate to which she refers is a fairly accurate figure of a female tarantula with a large oval cocoon attached to her abdomen in the way usual to Lycosids.[2] I have the opinion that the egg cocoon of the spider was mistaken by Madamoiselle Merian or her informants for a "domicile." At all events we may consider that it is fairly well assured that, in her cocooning habits, the female tarantula throughout most or perhaps all species, closely resembles the Lycosoidæ, and the resemblance probably extends to all the Territelariæ. In other words, the Theraphosid cocoon is (1) round or ovoid, (2) is carried about with the mother, attached to her body, or kept under her care, and (3) the young for a period longer or shorter remain with their mother. The affinity between these two great groups of araneads is also marked in their nesting habits; both burrow in the ground a cylindrical tunnel or shaft within which they domicile, sometimes lining it more or less completely with silk.[3]

7. *Attitude at rest and in attack.*—While resting upon its silken rug a favorite position of the tarantula was as follows: On one side the first leg and the last leg were well extended, the feet were lifted a little distance above the ground. The second and third feet were

[1] Communications Essex Institute, Vol. v., 1866—67, p. 61. "Researches and Experiments upon silk from Spiders and upon their reproductions, by Raymond Maria de Termeyer." Translated from the Italian, and revised by Burt G. Wilder.

[2] Desertation sur la Generation et les Transformations des insects de Surinam. Mariae Sibillae Merian. A la Haye, mdccxxvi.; Fig. 18 and explication.

[3] I purpose tracing this resemblance more in detail in a subsequent paper on "Nesting Habits of the American Purseweb Spider, Atypus niger."

placed upon the ground. On the opposite side, the legs rested upon the surface. One of the palps was lifted up; the other touched the earth. Sometimes when slightly alarmed or its attention was attracted by any noise or agitation, all the fore feet, the two pairs on each side, as well as the palps, would be raised from the ground and slightly thrown back. If the alarm or excitement increased the whole fore part of the body would gradually be raised, the legs and palps thrown backward in a curved position, and the mandibles also bent back, slightly separated and ready for striking. In this rampant attitude the body rested upon the two hind pairs of legs which were rather extended, and on the third pair which were slightly bent and pressed firmly against the soil. As they were more or less stiffened and straightened the body would be thrown backward or depressed. This was the position invariably taken by the tarantula when angry, and from this position it would spring forward and strike any object which excited its wrath, or which it wished to destroy.

Having struck out, which was done by bringing down palps, fore paws and fangs together upon the victim, the creature sank back into its rampant position. If so inclined it could rapidly repeat this movement. The whole attitude was an admirable expression of anger and readiness to strike for defence or offence. In the fine muscular exhiliration imparted by the creature's passion, the limbs assumed such graceful curves, and the pose of the body showed so happy a combination of vigor and ease, that the formidable spider really looked beautiful. It could stand in this rampant attitude with motionless rigidity for many minutes.

Among these notes of the general habits of the tarantula I may place the following, also communicated to me by Mr. Holstein. His observation of the tarantulas in Texas convinces him that they are very irritable. They will jump at least ten inches if they are excited thereto by sticks, although they are otherwise not inclined to be troublesome. He has known them to jump almost as high as his horse's knee. In the sandy country along the Colorado River in Texas they are very numerous, and one became so en one day as to run up the horse of one of the company as far ; shoulder before it was knocked off. Some Texans say t it infallible sign of rain to see these creatures crawling

I have myself captured them in Te: without was never able to find anything satisfactory

except the fear which they show when the famous wasp popularly called "the tarantula killer," *Pompilus formosus*, happens to be in the neighborhood. The excited haste with which the huge spider hurries off into hiding, when one of these formidable hymenopters is near is a very striking sight.[1]

[1] The following note was received from the author of the above paper just as the printed pages were going to press, and work thereon has been stopped in order to admit the explanation.—The Editor.

DR. EDWARD J. NOLAN,

Dear Sir:—

I have this morning received a note from Sir John Lubbock dated January 6th, in which he says "My old ant queen is still alive, but I fear a little stiff."

I am not able to explain the discrepancy between this statement and the account given of the apparent death of the same insect in my paper (page 370). It is evident, however, that both Sir John and myself were deceived by what must have been a transient suspension of activity. I saw the ant, and carefully observed it for five minutes or more, and am confident that it had the undoubted appearance of death. Sir John must have been laboring under the same mistake for at least a day.

I have no explanation of the phenomenon which thus deceived one of the most careful observers of emmet habits in England, to say nothing of myself. I await anxiously the explanation, for which I have written, of this apparent "resurrection," but in the meantime am desirous that some statement shall be got into or attached to my paper, to modify in accordance with present facts what I therein say.

If the work has not too far progressed to allow this, will you please see that this note or the substance thereof, is inserted at the end of the paper.

Very truly yours,

HENRY C. MCCOOK.

DESCRIPTION OF TWO NEW SPECIES OF FISHES FROM SOUTH AMERICA.

BY DAVID STARR JORDAN.

Cristiceps eigenmanni, sp. nov.

Head 4 in length to base of caudal; depth 4. D. III–XXIX, 2: A. 27 or 28. Scales in lateral line about 80. Type No. 12556 M. C. Z.

Body rather stout, compressed. Eye nearly twice as long as the sharp snout. Maxillary reaching to about opposite front of pupil. Tentacle on top of head small, shorter than pupil. Hook on shoulder-girdle obsolete, the structure as in *Labrosomus*. First dorsal rather low, scarcely joined to second; soft dorsal of two very evident soft rays. Scales very small. Pectoral a little shorter than head. Color (in spirits) brown, much mottled, some dark cross-bars especially distinct on dorsal and anal; five of these on second dorsal, one on first dorsal, one on base of caudal, six on anal. Caudal and pectorals pale, finely barred. No dark ocellus on dorsal or anal.

The type of this species, 2½ inches in length, was dredged by the Hassler, off Bermeja Head in Northeastern Patagonia (Lat. 41° 17m. S: Long. 63° W). It is in good condition, and it is numbered 12556 on the register of the Museum of Comparative Zoology. I have named the species for my former assistant, Mr. Carl H. Eigenmann, who has contributed a good deal to our knowledge of the fishes of tropical America.

The species resembles *Auchenopterus* (*Cremnobates*) *marmoratus*, but the scales are much smaller than in *Auchenopterus*.

Myctoroperca xenarcha. sp. nov.

Head 2⅗ in length to base of caudal; depth 3. D. XI. 16. A. III, 11. Scales 110 to 115. Length of specimen especially described (24198, Museum of Comparative Zoölogy, from James Island, Galapagos) seven inches.

Allied to *Mycteroperca bonaci* and *Mycteroperca falcata*.

Body rather deep and compressed; head compr d, with rather short, sharp snout, which is 4½ in head; profile dep d above e Mouth large, the maxillary reaching beyond eye, 2$\frac{1}{10}$ I r-er canines small; upper canines (two in n directed forward. Eye small, 6½ in h l. width of eye. Interorbital area flat

trils small, the posterior scarcely the larger, separated from the anterior by one diameter, Angle of preopercle scarcely salient, but provided with coarser teeth; a rather sharp notch above it. Gill rakers moderate. X+18. Scales moderate, scarcely ctenoid.

Dorsal spines low, the outline of the spinous dorsal gently convex, the fourth spine longest, 3 in head. Soft dorsal high, its outline angular, the tenth ray produced, $3\frac{2}{3}$ in head. Anal fin formed as in *M. falcata*, its seventh ray produced, $2\frac{1}{5}$ in head, its posterior outline concave. Caudal subtruncate, the outer rays slightly produced. Pectoral $1\frac{3}{4}$ in head.

Color in spirits plain dark olivaceous, the edges of the fins scarcely darker.

Several specimens of this species from the Galapagos Islands are in the Museum of Comparative Zoölogy. These were mixed with specimens of the more common *Mycteroperca olfax*, from the same locality. Other specimens (10061 M. C. Z.) are from Payta, Peru. *Mycteroperca xenarcha* resembles *M. olfax* in form and color. In *M. olfax* however, the nostrils are close together, the posterior some three times the diameter of the anterior: the second and third dorsal spines are elevated, about half higher than the fourth. Both species have the angular anal fin as in *M. falcata*, a character also shown in less degree by *M. acutirostris* and *M. tigris*.

NOTE ON ACHIRUS LORENTZI.

BY DAVID STARR JORDAN.

In the review of the Pleuronectidæ of America and Europe, published by Jordan and Goss in the Report of the U. S. Fish Commission for the current year, mention is made of a species of Sole from Uruguay, described by Dr. Weyenbergh under the name of *Achirus lorentzi.* This description was at that time not accessible to us. Through the kindness of Señor Augustin Pendola, Secretary of the National Museum of Buenos Ayres, a copy has been recently sent to me. As the paper is very difficult of access, I have thought it well to reprint the description in these Proceedings.

Achirus Lorentzii, Weyenbergh. (Actas de la Academia Nacional de Ciencias Exactas, Buenos Aires, Tom. III. Entr. I. p. 13.)

"*Achirus lorentzii,* Weyenbergh.

"Esta nueva especie de la familia des los Pleuronectoideos, tiene alguna semejanza con la especie figurada en el "Atlas" del viaje de D'Orbigny, con el nombre de *Achirus lineatus* Lac.; pero las diferencias, sin embargo, son bastante grandes.

"La aleta dorsal no se extiende en al *Achirus Lorentzii,* como sucede en al *A. lineatus,* hasta el labio superior de la boca, ó hasta la nariz, sino únicamente hasta la altura del fin de la fisura agallar; su forma tambien es diferente. En *A. lineatus* esta aleta se aumente poco á poco, de manera que la parte posterior tiene, más ó menos, el doble de la parte anterior, formando uno linea regularmente encorvada. En *A. Lorentzii,* la parte posterior es igual á la anterior enanchándose ambas regularmente hasta tomar la parte más ancha, una forma aguda, hácia al medio, y como dirigiéndose los rayos todos á este punto. El número de estos es 40. En *A. lineatus* la aleta anal se extiende hasta la fisura agallar, y presenta la misma forma regularmente corvada. En *A. Lorentzii* la forma de la aleta anal es la misma que la de la aleta dorsal; su parte aguda y mas larga se encuentra un poquito mas á la cola, y esta aleta continúa solamente hasta dos cent. distante de la fisura agallar. El número de sus rayos es 38. El color de la superficie derecha es como el de *A. lineatus* de manera que puede llamarse muy bien color sepia oscura. Las manchas negras son ménos grandes y ménos oscuras que en *A. lineatus,* y las escamas un poco mas grandes. [illegible] color [illegible] ciego es blanco, lo que acontece casi [illegible] npre [illegible] diferencia notable es que *A. Loren*

arias y pequeñas, pero bastante distintas, de lo cual no se nota nada en la fig. de *A. lineatus* de D'Orbigny. Los pelos de la barba son ménos desarrollados en nuestro especie, y le faltan los apéndices en el labio superior, que se ven en la mencionada figura de *A. lineatus.* La boca es encorvada más rectangularmente en nuestra especie, y los ojos son más pequeños y más esféricos, encontrandose el ojo inferior que es mas chico, perfectamente en el angulo de la corvadura locale.

"Las lineas transversales, que han dada origen al nombre de *A. lineatus* se encuentran tambien en nuestro especie, pero son mucho ménos anchas, y á pesar de que el nùmero siempre parece el misura, no hay una regularidad muy constante ó tipica en la distribucion de estas lineas in en sus corvaduras.

"La linea lateral es mas gruesa y mas recta en *A. Lorentzii* que en *A. lineatus,* y en ésta dicha linea se encorva mucho mas, por la parte de arriba, y hácia la cabeza, que en nuestra especie.

"Los extremos purpúreos que se ven en la parta superior de las aletas dorsales y anales de *A. lineatus.* y en su aleta caudal, no se encuentran en *A. Lorentzii,* en éste tales partes son solamente un poco mas claras que lo demas de las aletas. El número de rayos en la aleta caudal es 19. En la membrana de las aletas se ven ambas especias los mismas pequeñas manchas negras.

"El tamaño mayor que conozco, de mi especie, es de dos decimetros de largo, desde la barba hasta la extremidad de la cola: 14 centimetros de ancho entre las dos extremidades agudas de la parte mas ancha de las aletas dorsal y anal.

"Parte mas gruesa del cuerpo, 18 milimetros.

"He encontrado este pescado en las aguas, al rededor de Santa Fé, pero en el Paraná mismo. Tambien lo he recibido del Uruguay.

"Me parece que ésta es la primera especie, de la interesante familia de los Pleuronectoideos, que ha sido encontrada en agua dulce, pues todas las que conocemos hasta ahora, viven en el mar, ó en gulfos y bocas que están en comunicacion directa con el mar; es decir, en agua salada ó salobre,. He dedicado esta especie al sabio botánico y célebre viajero alemen, Profesor Dr. D. P. G. Lorentz, ántes mi colega en esta Universidad, por haber sido él el primero que fijó mi atencion sobre la existencia de esta especie en nuestro pais."

This species seems to be a valid one—apparently allied to *Achirus lineatus* but distinguished, if Dr. Weyenbergh has counted correctly, by the small number of the fin rays. (D. 40, A. 38.)

Dr. Günther has identified it with *Achirus mentalis*, a species with D. 66, A. 48, but has given no reason for so doing.

Supplementary note.—In our Review of the *Pleuronectidæ*, we overlooked *Achirus fischeri* (*Solea fischeri*, Steindachner, Beitrage zur Kenntniss der Flusz-fische Sud-Amerkas, 1879, 13.), from Rio Mamone, a tributary of the Rio Bayano, near Panama. This seems to be "a valid species allied to *Achirus fonsecensis*, but with D. 61, A. 44, and the right pectoral of only a single ray.

In this connection, I may notice that the species called "*Plagusia*" of which the development has been traced by Prof. Alexander Agassiz, (Proc. Am. Acad. Arts Sci. 1878, XIV, Pl. 10, f. 171.) is not a "*Plagusia*" (i. e. *Symphurus*), nor is it a Sole at all, but the young of some *Platophyrs*, apparently *Pl. ocellatus*. Thus far, nothing is certainly known of the development of the Soles.

DECEMBER 6.

Mr. THOMAS MEEHAN, Vice-President, in the chair.

Twenty-six persons present.

The death of Evan Randolph, a member, was announced.

The origin of the Grassy Prairies.—Mr. Meehan said that in 1871 he had offered to the Academy some facts to show that the views of the origin of the prairies, at that time generally accepted, could not be sound, and he then suggested some points that must have had considerable influence in bringing about this tree-less condition. Among these points, he had named the annual prairie fires of the Indians. Given a sheet of grass to be annually burned over, and forests flanking it, trees, obviously, could not extend far. Young sprouts from a tree stump would not flower. It took a seedling tree or sprouts from a stump to persist in growth for a number of years before its flowering stage is reached. Hence, though trees should spring up on a grassy prairie, the annual burning to the ground preventing the sprouts from reaching maturity, would be an insuperable bar to the surrounding forests encroaching far on the area of the prairie.

A further consideration, since that time, made it evident, that tree seeds could scarcely get a chance to grow at all in these grassy places. He had studied the so-called "balds" or open grassy places on mountain tops and sides, surrounded on all sides by forests, where there had been no annual fires, and yet no trees. He referred particularly to such spots on Roan Mountain, North Carolina. There would be open spaces covered by a thick matted sod, the chief grass composing it being *Danthonia compressa.* Spruce, Fir, Oak, and representatives of other genera surrounded them on all sides. Though the trees may have been fifty or even a hundred years old, the grassy outline had evidently been definitely fixed years back, and had not since been encroached upon until these later times. Since cattle had been permitted to browse, young trees could be seen here and there springing up. If the browsing continued, trees would eventually cover the balds. In the past, seeds falling on the thick matted grass, could not grow. There would be too much light and too little moisture, so far from the ground. Should a seed sprout under such circumstances, the radicle would dry up before it pushed through the thick mass of grass to the necessary earth. Browsing cattle kept down the grass, and gave the seeds a chance to reach the ground, and their hoofs would often make the ground bare, and even tread the seeds beneath the surface. Though eaten to the ground, the trees would sprout again,—some get stronger and larger,—and some eventually get to be trees, finally shading and killing out the light-loving grass. While annual fires certainly prevented trees spreading over grassy areas, we could now account for their non-existence, even as young seedling plants.

Our own prairies afforded evidence of the soundness of these views. There would often be seen elevated peninsular-like arms stretching from the woody area into the grassy basins, or even little islands of elevated ground in the midst of the flat sea of soddy land, covered by trees of various kinds. These elevations by reason of drouth, lighter soil, or other special conditions, were unfavorable for the growth of the thick mass of herbaceous vegetation that possessed the land below. The seeds could not only sprout and become trees, but the absence of much grassy undergrowth saved them from serious effects from fire on lower prairie ground.

There could be no doubt these considerations fully accounted for the perpetuity of the grassy areas, and the inability of the forests to encroach thereon.

If we are now asked how these extensive areas were given over to grass in the first place, we may safely reply that the trees were not there to dispute with it for the possession of the ground, or they would have conquered. We may imagine the prairie region as in a state of transition from the paludose to the limose state, with ligneous or arborescent vegetation on the higher lands, many miles away. The tufty grasses would undoubtedly take possession long before their woody neighbors could come down from the hills and spy out the land. The struggle for life would be at the boundaries where the two forces met. The trees could not gain rapid advances, but by the overshadowing of their branches would weaken the grass beneath, and thus, by slow approaches, gradually conquer their weaker neighbors. In meadows, where cattle kept the coarse grass down, or where briars or light bushes kept tough grass from spreading, or where the ground was too gravelly or sandy or the native grasses not of a close tufty character, trees found no obstruction whatever in their endeavor to take possession of the soil.

December 13.

The President, Dr. Jos. Leidy, in the chair.

Twenty-three persons present.

Bot-larvae in the Terrapin.—Prof. Leidy remarked that the habits of a naturalist often led him to observe things in our daily life which usually escape the notice of others. In our food he had frequent occasion to detect parasites which he preferred to reject but which are unconsciously swallowed by others. While he liked a herring, he never ate one without first removing the c ic uously coiled worms on the surface of the rows; and he n repeatedly extracted from a piece of black bass or a shad a thre worm which others would not distinguish from a v or nerve. While he did not object to the little parasitic cra oyster, he made it a point to remove the equally frequent le the clam. It was in a piece of ham, he was eating, t

noticed the trichina, which was no doubt one of the causes that led Moses to declare the pig to be unclean; and in the hundred tapeworms he had examined, from our fellow citizens, during the past twenty five years, he had ascertained that they had all been derived from rare beef. He continued, in a visit to Charleston, S. C. before the late war, at an evening entertainment among other viands, were nicely browned slices of the drum-fish, *Pogonias chromis*. A friend informed him that some portions were more gelatinous and delicate than others and helped him to what was supposed to be one of such. On cutting into it he had observed imbedded in the flesh a soft mass which appeared of enigmatic character. The following day he procured from market a drum-fish on the dissection of which, he found imbedded in the tail several egg-shaped masses, about three inches long and less than an inch thick, which proved to be a large coiled worm, (*Acanthorhynchus reptans*).[1] This it was that gave delicacy to the dainty, and in this instance the parasite seems to enhance the excellence of the food. At another evening entertainment nearer home he partook of some stewed terrapins. Taking into his mouth what appeared to be an egg it produced such an impression as led to its rejection. Seeming so peculiar he tied it in the corner of his handkerchief for more convenient examination. The specimen, now exhibited, was a membranous bag which contained thirty yellowish white maggots from 8 to 12 mm long by 1.5 to 3 mm broad. They are the larvae of a bot-fly, and resemble those of the *Gastrophilus* of the horse. Their characters are as follow:—

Body of the larva fusiform, acute anteriorly, obtuse posteriorly, consisting of twelve segments including the head, which is armed with a pair of strong, black, hooked maxillae; terminal segment with a pair of trilateral oval, chitinous disks, each with three spiracles; intermediate segments with numerous minute recurved hooklets, disposed in incompletely separated bands at the fore and back part of the segments.

The sac containing the larvae is about three fourths of an inch long and half an inch broad, with a short tubular prolongation open at the extremity. It was uncertain whether the sac formed part of the intestine.

The dish of stewed terrapins was suspected to have been a mixture of the diamond-back, *Emys palustris* and the red-bellied terrapin *E. rugosa*. This is not the only instance of the occurrence of bots in turtles, as Prof. A. S. Packard notes the case of larvae being found in the skin of the neck of the box-turtle, *Cistudo carolina*.[2]

DECEMBER 20.

Mr. Geo. W. TRYON Jr. in the chair.

Twelve persons present.

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[1] Proc. A. N. S. 1858, 111.

[2] American Naturalist, 1882, 598.

A paper entitled "The Miocene Mollusca of the State of New Jersey," by Angelo Heilprin, was presented for publication.

Determination of the Age of Rock Deposits.—Prof Heilprin, referring to the methods that had been used by geologists and physicists to determine the rate of formation of rock masses, stated that in the case of the organically-formed rocks, especially those, like the chalk, which were largely in the nature of a deep-sea deposit, the data deduced from sedimentation and accumulation were of little or no value, since the rate of growth here was almost wholly dependent upon the rate of development of the oceanic organisms which use lime in the construction of their hard parts. In the deposit now accumulating along the sea-bottom, known as the Atlantic or Globigerina ooze, the speaker thought we had some direct clue bearing upon the solution of the problem. Manifestly, there can be no more rapid accumulation of the calcareous ooze than there is lime-carbonate suspended in the sea; and again, the quantity of lime-carbonate (in the form of microscopic tests and fragments) suspended in the sea must depend upon the quantity of the formative material contained in the sea—the quantity of lime carried in by the rivers. The researches of the officers of the Challenger expedition have shown that in a column of oceanic water of 600 feet depth, with a transverse area of one square mile, there are contained some 16 tons of suspended organic (foraminiferal) particles; these, if precipitated to the floor of the sea, would make a deposit $\frac{1}{10000}$ inch in thickness. Now, it would seem from careful observations made on many of the most important rivers of the globe[1] that the quantity of lime carried out by them into the sea annually is about one-sixth that of their suspended sediment, and would cover the sea-bottom, if precipitated at a rate proportional to that of the removal of continental sediment, one foot in 3000 years—to a depth of about $\frac{1}{4500}$ inch. Assuming that one-half of this amount is used by the Foraminifera for the construction of their shells, the rest being taken up by the mollusks, corals, etc., then the foraminiferal accumulation from this (apparently the only) available source would be the $\frac{1}{9000}$ part of an inch annually, or very nearly the amount that would accumulate from the droppings contained in the 600-foot column of water, as deduced from the Challenger determinations. At this extremely slow rate of accumulation, it would require a period of 100000 years to form a single foot, and where, as in the case of the Chalk, we have a similar deposit hundreds of feet in thickness, we would require a period of millions of years for its formation. The speaker stated that there were probably factors involved in a more rapid formation of the Atlantic ooze with which we were not acquainted, and it hardly appeared credible to him that the rate of formation could be as slow as the data indicate. But the method of calculation was based upon tangible facts, and was accordingly interesting.

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[1] Mellard Reade, Presidential Addre]

DECEMBER 27.

Mr. THOMAS MEEHAN, Vice-President, in the chair.

Seventy persons present.

The death of Dr. Ferdinand V. Hayden, a member, was announced.

Papers under the following titles were presented for publication:—

"Description of New Species of Uniones from Florida." By Berlin Hart Wright.

"A Bibliographic and Synomymic Catalogue of the Genus Auriculella Pfr." By Wm. D. Hartman M. D.

"A Bibliographic and Synomymic Catalogue of the Genus Achatinella Swnsn." By Wm. D. Hartman M. D.

The following was ordered to be printed:—

THE MIOCENE MOLLUSCA OF THE STATE OF NEW JERSEY.

BY PROF. ANGELO HEILPRIN.

The known forms of miocene mollusca of the State of New Jersey numbered up to 1884, the year when I published my "Contributions to the Tertiary Geology and Paleontology of the United States," some thirty species, as follows:

Ostrea Virginica (*O. Mauricensis.*)
Ostrea percrassa
Pecten Humphreysii
Plicatula densata
Mytilus inflatus ?
Lithodomus subalveatus
Carditamera aculeata
Carditamera arata
Crassatella melina
Astarte Thomasii
Astarte distans
Mysia parilis
Yoldia limatula
Venus Ducatellii
Venus plena
Mercenaria cancellata
Tellina Shilohensis
Tellina peracuta
Tellinella(?)capillifera
Thracia myœformis
Anatina alta
Corbula elevata
Saxicava parilis
Turbinella Woodi
Fulgur scalariformis
Natica catenoides ?
Turritella æquistriata
Turritella Cumberlandia
Turritella secta
Fissurella Griscomi.

Several excursions with my class to the "marl" diggings near Shiloh, Cumberland Co., and the examination of material from an artesian well-boring in Atlantic City (kindly placed in my hands by Mr. Lewis Woolman), enable me to increase this list by about fifty species, of which some four or five prove to be new forms. The following species have been identified from the diggings near Shiloh:

Ostrea percrassa
Pecten Humphreysii, var. Woolmani (Heilprin)
Pecten Madisonius
Plicatula densata
Mytilus inflatus
Mytiloconcha incurva
Lithodomus sp.?
Perna maxillata
Arca centenaria
Arca Marylandica
Pectunculus lentiformis
Nucula obliqua
Yoldia limatula
Astarte distans
Astarte compsonema
Crassatella melina
Carditamera arata
Carditamera aculeata
Lucina crenulata
Cardium laqueatum
Chama congregata
Venus athleta
Venus mercenaria?
Venus (Mercenaria cancellata? Gabb.)
Mactra lateralis
Tellina sp.?
Teredo sp.?
Saxicava parilis? (S. insita?)
Murex nov. sp.
Turbinella Woodi
Fulgur scalariformis
Cantharus Cumberlandianus
Nassa trivittata
Columbella communis

Terebra curvilirata
Triforis nov. sp.
Cancellaria sp.?
Marginella sp.?
Pleurotoma nov. sp.
Turbo eboreus
Carinorbis (*Delphinula*) *globulus*
(*D. lyra?* Conrad)
Natica hemicrypta
Turritella Cumberlandia
Turritella æquistriata
Trochita centralis
Crucibulum costatum
Crepidula fornicata
Crepidula plana?
Fissurella Griscomi
Discina (*Orbicula*) *lugubris*

Of the species here indicated the greater number have been found in States other than New Jersey, and leave no doubt that the deposits which they represent constitute a part of the regular Miocene series of the Atlantic border. The general faunal facies is most nearly that of the Lower Atlantic Miocene ("Marylandian") or Middle Atlantic Miocene ("Virginian"), with a decided leaning toward the former, whose position it occupies geographically. I have elsewhere (Proc. Acad. Nat. Sci. Phila., 1880 pp. 31–32; Contrib. Tert. Geol. and Paleont. U. S., p. 9,) given reasons for referring these Cumberland County deposits to the "Marylandian" division of the Atlantic Miocene, a reference which appears justified, apart from other considerations, by the presence of such fossils as *Ostrea percrassa, Pecten Humphreysii, Perna maxillata, Crassatella melina,* etc. These species belong to the Lower Miocene (Contrib. Tert. Geol. and Paleont. U. S., pp. 71 and 77), and characterize principally the basal series of deposits. Indeed, it is a little questionable if they do not actually connect with the Oligocene.

The newer Miocene deposits, as determined by their fossil remains, had not been recognized in the State prior to the present year, although the existence of such deposits in their proper position could not reasonably be doubted. In my work above referred to (1884) I remark (p. 9): "It is very likely that both divisions of the Miocene indicated by me as occurring in Maryland and Virginia,

and by me designated as the 'Marylandian' and 'Virginian,' or the lower and middle Atlantic Miocenes respectively, will eventually be found to be equally well-marked off in New Jersey, although up to the present time, from the sparseness of the fossil remains that have been collected, no such subdivision could be satisfactorily attempted. But from what material we have at hand, it may be safely asserted that the localities which have been so assiduously searched in the neighborhood of Shiloh, and elsewhere in Salem and Cumberland Counties, belong to the older, or 'Marylandian' division."

The existence of the newer Miocene deposits has now been definitely determined through the material obtained by Mr. Woolman from the artesian boring at Atlantic City, which has been placed in my hands for examination. The species of fossils obtained here are the following:

Discina lugubris
Ostrea sp.?
Anomia ephippium?
Pecten Madisonius
Pecten Humphreysii
Pecten vicenarius?
Perna maxillata
Mytilus incrassatus
Mytiloconcha incurva
Arca centenaria
Arca subrostrata
Arca idonea?
Arca lienosa?
Nucula obliqua
Astarte compsonema
Astarte obruta
Astarte perplana?
Astarte Thomasii
Cardita granulata
Carditamera arata
Crassatella melina
Cardium (laqueatum?)
Lucina trisulcata?
Lucina crenulata
Mysia sp.?

Cytherea Sayana?
Artemis acetabulum?
Venus sp.?
Donax variabilis
Mactra lateralis
Mactra ponderosa?
Tellina declivis
Tellina subreflexa
Corbula idonea
Corbula elevata
Turbinella Woodi
Fulgur sp?
Nassa trivittata
Natica sp.?
Turritella Cumberlandia
Turritella æquistriata
Turritella plebeia
Barnacles
Echinoid fragments
Dendrophyllia (coral)
Lamna compressa
Odontaspis
Myliobatis
Crocodilian bone

Many of the species occur only in fragments, but the greater number admit of definite determination. Unfortunately, in most instances, the depth at which they were obtained could not be ascertained, and in so far, therefore, such species give but little positive evidence as to the horizons which they actually represent. But the introduction of a very considerable number of forms, as compared with the number of such forms occurring in the deposits near Shiloh, which are more or less characteristic of the "Virginian" (Middle Atlantic Miocene) deposits, and those of still newer date ("Carolinian"), leave no room for doubt that a distinct faunal horizon,—the correspondent, in all probability, of the Middle Miocene—is penetrated by the bore. Again, that the older beds are also represented is proved by the occurrence of *Perna maxillata, Pecten Humphreysii, Crassatella melina,* etc., but only in the case of the first-named species, *Perna maxillata,* could the absolute position—depth of some 800 feet—in the section be obtained. The po-

sition here indicated accords approximately with the theoretical position deduced from a calculation of dip and strike, using the Shiloh Perna beds as an equivalent. At a height of some 350 feet above the Perna beds, and consequently, at an actual depth of about 450 feet, occurs a stratum containing large numbers of *Turritella plebeia*, a species, which in Maryland, incisively marks the newer Miocene deposits of the State (*i. e.* the "Virginian"), as distinguished from the older ("Marylandian"). Its presence in the position which it occupies in the Atlantic City bore section would, of itself, be almost sufficient to determine the existence of a second faunal horizon.

The following table enumerates, as far as is known to me, all the Molluscan species that have been thus far determined from the Miocene formation of the State:

Discina lugubris, Conr. Mioc. Foss., p. 75.
Ostrea Virginica (*O. Mauricensis*) Gmel.
Ostrea percrassa, Conr. Mioc. Foss., p. 50.
Pecten Humphreysii, Conr. Bull. Nat. Inst., p. 194.
Pecten Madisonius, Say. Journ. A. N. S., IV. p. 134.
Pecten vicenarius ? Conr. Proc. A. N. S., 1. p. 306.
Anomia ephippium ? L.
Plicatula densata, Conr. Proc. A. N. S. 1. p. 311.
Mytilus inflatus, Tuomey and Holmes. Plioc. Foss., p. 33.
Mytilus incrassatus, Conr. A. J. Science, XLI., p. 247.
Mytiloconcha incurva, Conr. Mioc. Foss., p. 52.
Lithodomus subalveatus, Conr. A. J. Conch., II, p. 73.
Perna maxillata, Lam.
Arca centenaria, Say. Journ. A. N. S., IV., p. 138.
Arca Marylandica, Conr. Mioc. Foss., p. 54.
Arca subrostrata, Conr. Mioc. Foss., p. 58.
Arca idonea ? Conr. Foss. Tert. Form., p. 15.
Arca lienosa ? Say. Amer. Conch., pl. 36.
Pectunculus lentiformis, Conr. Mioc. Foss., p. 64.
Nucula obliqua, Say. A. J. Science, II, p. 40.
Yoldia limatula, Say. Amer. Conch., pl. 12.
Astarte compsonema, Conr. A. J. Conch., II, p. 72.
Astarte obruta, Conr. Journ. A. N. S., VII, p. 15.
Astarte perplana ? Conr. Mioc. Foss., p. 43.
Astarte Thomasii, Conr. Proc. A. N. S., VII, p. 267.
Astarte distans, Conr. Proc. A. N. S., 14, p. 288.
Crassatella melina, Conr. Mioc. Foss., p. 22.

Cardita granulata, Say. Journ. A. N. S., IV., p. 142.
Carditamera arata, Conr. Mioc. Foss., p. 11.
Carditamera aculeata, Conr. Proc. A. N. S., 14, p. 585.
Lucina crenulata, Conr. Mioc. Foss., p. 39.
Lucina trisulcata? Conr. A. J. Science, XLI, p. 346.
Mysia parilis, Conr. A. J. Conch., II, p. 71.
Mysia sp.?
Chama congregata, Conr. A. J. Science, XXIII, p. 341.
Cardium laqueatum, Conr. Mioc. Foss., p. 31.
Cytherea Sayana, Conr. Mioc. Foss., p. 13.
Venus Ducatellii, Conr. Mioc. Foss., p. 8.
Venus plena, Conr. A. J. Conch., V, p. 100.
Venus latilirata, Conr. Proc. A. N. S., 1, p. 28.
Venus sp.?
Mercenaria cancellata, Gabb. Journ. A. N. S., IV, p. 376.
Artemis acetabulum, Conr. Foss. Tert. Form, p. 20.
Mactra lateralis, Say. Journ. A. N. S., II, p. 309.
Mactra ponderosa? Conr. Journ. A. N. S., VI, p. 228.
Donax variabilis, Tuomey and Holmes. Plioc. Foss. p. 95.
Tellina Shilohensis
Tellina declivis, Say. Journ. A. N. S., VII, p. 131.
Tellina peracuta, Conr. A. J. Conch., II, p. 71.
Tellinella capillifera, Conr. A. J. Conch., II, p. 71.
Amphidesma subreflexa, Conr. Journ. A. N. S., VII, p. 133.
Thracia myæformis, Conr. Proc. A. N. S., 14, p. 585, as *Saxicava.*
Anatina alta, Conr. Proc. A. N. S. 14, p. 585.
Corbula elevata, Conr. Mioc. Foss., p. 7.
Corbula idonea, Conr. A. J. Sci., XXIII, p. 341.
Saxicava parilis, Conr. A. J. Conch., II, p. 70.
Saxicava incita?
Teredo sp.? Conr. A. J. Conch., v, p. 101.
Murex nov. sp.
Turbinella Woodi, Gabb. Journ. A. N. S. (2d ser.) IV, p. 375.
Cantharus Cumberlandianus, Gabb. Journ. A. N. S., 2d ser., IV, p. 375.
Fulgur scalarispira, Conr. Proc. A. N. S., 14, p. 584.
Nassa trivittata, Say. Journ. A. N. S., II, p. 231.
Columbella communis, Conr. Proc. A. N. S., 14, p. 287.
Terebra curvilirata, Conr. Proc. A. N. S., 1, p. 327.
Triforis nov. sp.

Cancellaria sp.?
Marginella sp.?
Pleurotoma nov. sp.
Natica hemicrypta, Gabb. Journ. A. N. S. (2d ser.), IV, p. 375.
Natica catenoides? Wood. Crag. Moll., p. 141.
Turbo eboreus, Wagner. Journ. A. N. S,, VIII, p. 52,
Carinorbis (*Delphinula*) *globulus*, H. C. Lea. Trans. Am. Phil. Soc, [IX, p. 262.
(*D. lyra?* Conrad.)
Turritella æquistriata, Conr. Proc. A. N. S., 14, p. 584.
Turritella Cumberlandia, Conr. Proc. A. N. S., 14, p. 584.
Turritella secta, Conr. Proc. A. N. S., VII, p. 268.
Turritella plebeia, Say. Journ. A. N. S., IV, p. 125.
Trochita centralis, Conr. A. J. Science, XLI, p. 348.
Crucibulum costatum, Say. Journ. A. N. S., IV, p. 132.
Crepidula fornicata, Say. Journ. A. N. S., II, p. 225.
Crepidula plana? Say. Journ. A. N. S., II, p. 226.
Fissurella Griscomi, Conr. Mioc. Foss., p. 78.

The references to descriptions do not necessarily indicate first description.

Notes on New and Old Species.

Murex Shilohensis. nov. sp.

Whorls about seven, angular, flattened on the shoulder, which is crossed diagonally by the variceal ridges; varices about eight on the body-whorl, sub-equal, spinosely elevated on the shoulder angulation, and crossed by four sub-equal revolving ridges, which appear double on the crests of the varices; only two such ridges on the whorls above the body-whorl.

Aperture somewhat more than half the length of shell, key-hole shaped, with the canal broadly deflected. Length nearly ·75 inch.

A single specimen from Ayres' pits, near Shiloh, in the possession of Miss Emma Walter, of Philadelphia.

Pleurotoma pseudeburnea. nov. sp.

Spire elevated, of about ten volutions; apex papillate; whorls convex, porcellanous, strongly ribbed, somewhat impressed on the shoulder; ribs numerous, deflected, those of the several whorls alternating in position. No revolving lines.

Aperture about one-third the length of shell; canal slightly deflected; columellar lip well defined.

Length, slightly exceeding a half-inch.

From Ayres' pits near Shiloh. Fairly abundant. From the collection of Miss Mary S. Holmes, of Philadelphia.

Triforis terebrata. nov. sp.

Spire gradually tapering, nearly parallel-sided; whorls? flat, ornamented (on the body-whorl) with two prominently beaded lines, and two alternating lines of smaller beads; on the whorls above the body-whorl the lowest line is indistinct, or entirely covered over; transverse lines connect the beads of the different series; columella smooth, arcuate.

Length, ?

A fragment only, showing three whorls, from Ayres' pits, near Shiloh; in the possession of Miss Ella Lyndall, of Philadelphia.

The species appears to be most closely related to *Cerithium (Triforis) moniliferum*, of H. C. Lea.

Pecten Humphreysii, var. **Woolmani.**

Under this name I propose to designate a Pecten, which appears to be only a variety or sub-species of the Maryland *P. Humphreysii*, differing from the normal type of that species in the greater elevation of the ears, and the more distinct quadrangulation of the ribs of the convex valve. The ribs are also more prominently lined. All the New Jersey specimens that I have seen of what appears to be *Pecten Humphreysii* agree in these characters.

Illustrations of these species will be given in a future paper.

Note. Since the preparation of the above Mr. Woolman has obtained from the Atlantic City boring *Nassa obsoleta*, the impression of a fish-scale, and several Foraminifera (*Cristellaria*, *Robulina*, etc.)

The following annual reports were read and referred to the Publication Committee:—

REPORT OF THE RECORDING SECRETARY.

The operations of the various departments of the Academy are so fully set forth in the reports of the several officers and Sections that little remains for the Recording Secretary to note of the history of an uneventful but prosperous year except the statistics of publication and exchange.

One hundred and three pages of the Proceedings for 1886 and three hundred and twenty-eight pages of the volume for 1887 have been issued, the former being illustrated by two and the latter by fifteen plates. The second part of the ninth volume of the quarto Journal, consisting so far of papers by Profs. Wm. B. Scott and Henry F. Osborn is in process of preparation, but, in consequence of an unavoidable change of printers, the work progresses with dis-discouraging slowness.

Three titles have been added to our exchange list, increasing the number of copies of the Proceedings now distributed to foreign correspondents to 382. In addition sixty one copies are mailed to domestic exchanges and one hundred and fourteen to subscribers, making the whole number of each issue sent out 557.

Twenty-five papers have been presented for publication as follows:—Henry F. Osborn 3, Geo. A. Koenig 2, C. A. White 2, David Starr Jordan 2, C. Rominger 2, Joseph Leidy 1, Otto Meyer 1, Thomas C. Porter 1, Harrison Allen 1, Andrew Garrett 1, Adele M. Fielde 1, Edw. Potts 1, Henry C. Chapman 1, Carl F. Eigenmann 1, John A. Ryder 1, Angelo Heilprin 1, Thomas Meehan 1, Henry C. McCook 1, Charles Wachsmuth and Frank Springer 1. One of these has been accepted for publication in the Journal and the others will form part of the current volume of the Proceedings.

Communications have been made at the meetings by Messrs Allen, Heilprin, Ryder, Holman, Foote, Koenig, Meehan, Rusby, McCook, Leidy, Brinton, Sharp, Wilson, Binder, Kelly, Trotter, Dolley, Martindale, Willcox, Chapman, Cresson, Parker, Woolman, Cheston Morris and Jefferis. When reported by their authors these, together with occasional notes on the natural history of Swatow,

China, by Miss Fielde, have been published as minor articles in the Proceedings. The practice of reporting the meetings in a popular form for the newspapers has been continued as far as possible.

The average attendance at the meetings has been 21.

Seventeen members and sixteen correspondents have been elected. The deaths of ten members and three correspondents have been recorded in the published Proceedings. Resignations of membership from John B. Deaver M. D., W. L Springs and W. H. Harned were accepted on the usual conditions.

The Academy was represented at the banquet in celebration of the Centenary of the Adoption of the Federal Constitution by a committee consisting of Messrs Thomas Meehan, Jacob Binder and Theo. D. Rand.

Nine of the portraits in oil belonging to the Academy have been loaned to the Academy of Fine Arts as a portion of the interesting collection of historical portraits now being exhibited to the public.

All of which is respectfully submitted.

EDW. J. NOLAN,
Recording Secretary.

REPORT OF THE CORRESPONDING SECRETARY.

The duties of the Corresponding Secretary have shown but little variation during the past year, the letters received being almost entirely those of transmission of publications or acknowledgement of the reception of those sent by us.

The plan adopted some time ago of sending our Proceedings by mail, in parts as completed, has caused the number of letters of acknowledgement to exceed those of transmittal.

Publications acknowledged by circular letter, .	64
Those acknowledged by Postal Card, . . .	32
The latter about equally divided between native and foreign societies.	
Letters of transmittal, ...	28

These are for the most part from societies and others who send through the International Exchange.

Among the letters were eight asking the Academy to supply deficiencies. While it has been possible to reply favorably to the demand in nearly every case, some could not be so treated. Unfortunately

some of our earlier volumes are either entirely or partly out of print, but it is hoped the finances of the Academy may permit republication in the near future.

During the year sixteen Correspondents have been elected and notification promptly sent. Responses have been received from fifteen, in several cases accompanied by gifts to the library or museum.

The additions to the museum during the year have been of great value as will be learned from the Curators' report. To the Curator-in-charge I must express my thanks for acknowledging in my behalf, the donations as received.

Among the miscellaneous correspondence we have received notification of the death of eminent students many of whom were numbered among our membership.

A number of letters of slight interest have been referred to the members of the Bureau of Scientific Information or answered directly.

Respectfully submitted,

GEORGE H. HORN, M.D.,

Corresponding Secretary.

REPORT OF THE LIBRARIAN.

The additions made to the library during the year ending November 30, 1887 amount to 3380. They consist of 447 volumes, 2908 pamphlets, part of periodicals and of works issued in numbers and 25 maps, sheets etc.

A complete catalogue of these additions is appended. They have been received from the following sources:—

Societies,	1283	Smithsonian Institution,	3
Editors,	836	Geological Survey of Russia,	3
I. V. Williamson Fund,	673	Hon. Chas. M. Betts,	3
Authors,	231	Dr. W. S. W. Ruschenberger,	2
Brazilian Government,	83	Angelo Heilprin,	2
Mr. John H. Redfield,	37	U. S. War Department,	2
Wilson Fund,	35	Geological Survey of Portugal,	2
U. S. Department of the Interior,	27	Mexican Government,	2
Executors of Dr. George Martin,	19	Publishers,	2
In Exchange,	14	Pennnsylvania State Board of Health,	1
U. S. Department of State,	12	R. Schomburgk,	1
By Subscription,	10	Yale College,	1
H. B. M. Government,	10		

Geological Survey of Canada,	9	Fish and Game Commissioners, Mass,	1
Thomas Meehan,	8	G. W. Carpenter & Co.	1
Geological Survey of Kentucky,	8	B. H. Warren,	1
Geological Survey of New Jersey,	7	Messrs Tiffany & Co.	1
Geological Survey of India,	7	Department of Mines, Nova Scotia,	1
U. S. Treasury Department,	7	W. E. D. Scott,	1
Norwegian Government,	7	Chas. E. Smith,	1
United States Department of Agriculture,	6	E. V. d'Invilliers,	1
Geolgical Survey of New Zealand,	4	Isaac Burk,	1
British Museum,	4	Robert Nebinger,	1
U. S. Fish Commission,	4	Mrs. Joseph E. Mitchell,	1
Minister of Public Works France,	4		

They were distributed to the several departments of the library as follows:—

Journals,	2506	Agriculture,	9
Botany,	254	Medicine,	8
Geology,	189	Mammalogy,	8
General Natural History,	101	Helminthology,	7
Conchology,	55	Public Documents,	7
Entomology,	46	Ichthyology,	6
Anatomy and Physiology,	31	Chemistry,	6
Voyages & Travels,	24	Ornithology,	4
Anthropology,	19	Geography,	4
Bibliography,	15	Herpetology,	1
Encyclopedias,	14	Microscopy,	1
Physical Science,	13	Miscellaneous, (unclassified),	23
Mineralogy,	13		

The Academy is to be congratulated upon at last securing an almost complete set of De Martius' Flora Brasiliensis from the government of Brasil. Our thanks are due Prof. Orville A. Derby for efficiently endorsing our repeated applications to the Ministry of Agriculture, Commerce and Public Works for this most important addition to the botanical library. From the parts received we have been enabled to bind eighteen volumes and efforts are being made to obtain the numbers required to complete the set to date. Among the other distinctively important works added during the year mention may be made of a complete set of Pflüger's Archiv, in forty volumes, and a beautiful colored copy of Sibthorpe's Flora Graeca, ten volumes folio. The latter has been obtained partly through the I. V. Williamson Fund and partly by subscriptions from Messrs Thomas Meehan, Chas Schäffer, John H. Redfield, W. S. W. Ruschenberger, Isaac C. Martindale, Aubrey H. Smith, Geo. H. Horn, Wm. C. Henszey, Wm. W. Jefferis, Jacob Binder and Geo. A. Binder.

Special acknowledgments are also due to Mr. John H. Redfield for thirty-seven volumes of botanical works not before possessed by the Academy and treating for the most part of ferns; to the executors of Dr. Geo. Martin for nine volumes on cryptogamic botany and to Her Britannic Majesty's Government for the continuation of the invaluable reports of the Challenger Expedition, thirty-two volumes of which have been received.

The accompanying list of accessions indicates our continued indebtedness to the Isaiah V. Williamson Fund, which, after our exchanges, continues to be the most important source of the library's growth.

I am happy to be able to report that the crowded condition of the cases devoted to the journals has been in a measure relieved by the erection of about one thousand feet of additional shelving. Advantage has been taken of the increased accommodation to again revise the catalogue of periodicals. The work progresses very slowly in consequence of the absence of assistance and the limited time that can be given to other than current work. It is intended, however, as the revision progresses, to again apply to corresponding societies for such deficiencies as may still exist, repeated applications being sometimes necessary before a satisfactory return can be obtained. Although the applications sent out during the last two or three years have been productive of encouraging results, many societies have not been heard from either negatively or affirmatively, and these will receive special attention.

I have been again indebted to friends of the Academy for the means of securing the services of Signore E. Fronani during the summer months. His entire time has been devoted to the work of transcribing my original card entries, and the new catalogue has progressed so far as to be in fit condition for use. The case for its reception was designed and its construction supervised by Mr. Jacob Binder, to whom the Academy is also indebted for the satisfactory completion of the additional library cases. The few cards remaining to be copied (next year, it is hoped) have been placed temporarily with the others and, as now arranged, the catalogue supercedes entirely the hand-lists of the special departments of the library formerly in use, one defect of which, among many, was that the alphabetical arrangement could not be maintained for any length of time. In as much as it is easier to glance down a printed or written list than to turn over a number of cards it may be that there are

certain inconveniences in the use of a card catalogue by specialists who, for the most part, desire to consult only the books belonging to their own department, but the accuracy of the alphabetical arrangement and the certainty of finding the entry in its proper place with an indication of the position of the book in the library, more than counterbalance the disadvantages.

Two hundred and thirty-four volumes have been bound during the year. They were mostly special works received in numbers and some I. V. Williamson journals. Hundreds of volumes of periodicals yet remain to be bound. An effort is being made to lessen the inconvenience of consulting these by glueing the numbers of each volume firmly together, but this cannot be considered more than a temporary expedient and it is earnestly hoped that means may be soon provided for their permanent arrangement.

An interesting portrait in oil of Thomas Say, formerly one of the series belonging to Peale's Museum, has been received from Mrs. Joseph E. Mitchell.

All of which is respectfully submitted.

EDW. J. NOLAN.

Librarian.

REPORT OF THE CURATORS.

The Curators present the following statement of the Curator-in-Charge as their report for the year 1887 :—

The Curator-in-Charge respectfully reports that the collections of the Academy are, generally speaking, in good condition, and that there has been but insignificant loss to the Museum through either carelessness or unintentional neglect. The various departments of the institution have been more or less dependent for their development upon the volunteer labors of specialists in their several sections, and for the valuable assistance thus rendered the Curator-in-Charge desires to express his grateful acknowledgements. The thanks of the Academy are especially due to Mr. George W. Tryon, Jr., Conservator of the Conchological Section, to Mr. J. H. Redfield, Conservator of the Herbarium, and to Mr. Jacob Binder, Conservator of the collection of minerals bequeathed to the Academy by the late Mr. Wm. S. Vaux, who have severally devoted much time and labor to the interests of the collections under their charge. To the

Entomological Section, likewise, acknowledgement is due for work done in connection with the caring for the collection of insects.

In the departments other than those here specified the work has been done under the immediate superintendence of the Curator-in-Charge and his assistant, Mr. J. E. Ives, whose services were secured in the early part of the year. As in previous years, the entire collection of alcoholics has been carefully overhauled, and specimens no longer serviceable—of which there were but few in number—removed from the bottles.

Much the greater part of the Curator's attention has been given to the collections of the main floor, which have been largely rearranged to the end of rendering them more accessible and of securing room for further collections. The large centre cases devoted to osteology have been turned lengthwise with the building, and a number removed to other parts of the hall, thereby necessitating an almost complete rearrangement of the collections contained therein. This has been accomplished with a nearer approach to system than has been possible heretofore. The bird and reptile skeletons have been removed to their respective departments on the first and second galleries, while the mammalian skeletons retain their former positions along the south wall. The greater number of these last have been carefully compared and redetermined, and the errors of previous determinations corrected and eliminated; it is believed that, with a few exceptions, concerning which there is no record, all the forms are now authoritatively determined, and arranged in accordance with the most approved system of classification. The nomenclature of Prof. Flower, Director of the British Museum, has been largely followed.

One of the most important pieces of work of the year has been the preparation of a complete catalogue of mammalian osteology, for which the Academy is principally indebted to Mr. Ives, the assistant to the Curator-in-Charge. The number of specimens therein recorded is 925, divided as follows among the several orders:—

Primates,	109	Rodentia,	191
Carnivora,	297	Edentata,	18
Ungulata and Proboscidea,	205	Insectivora,	17
Cheiroptera,	2	Didelphya,	19
Cetacea,	62	Monotremata,	1
Sirenia,	9		

It will thus be seen that while some of the orders are largely represented, others are very deficient, and require much in the way of addi-

tion before they can be considered to be in any way sufficient. The Academy has received much assistance toward filling gaps from the Zoological Society of this city, which has on several occasions donated some of the rarer animals which, through death, were no longer serviceable in the Zoological Gardens. Among these may be enumerated a hippopotamus, kangaroo, wombat, echidna, etc. It is hoped that with more intimate relations between the two institutions further advantages of this kind may be acquired. It is a singular fact in connection with the development of an institution like the Academy, that while its collections frequently embrace numbers of specimens that are considered rare, and not ordinarily obtainable, other specimens, much more common, are largely or wholly wanting. Thus, in the case of our own institution, while there is what might be termed a superabundance of the skulls of tigers, bears and wolves, there is not a single complete skeleton of the ordinary cow or ox, sheep or goat; and it was only during the course of the present year that the Academy obtained, through purchase ($100), the skeleton of the American bison. The disarticulated parts of a second individual were received at about the same time from the Smithsonian Institution at Washington, through the good offices of the late Prof. Spencer F. Baird. It is especially desirable that the commoner animals should have a representation in the museum, and it is earnestly to be wished that the museum fund may be so far increased as to permit of purchases in this direction.

In the department of Ornithology, the Academy has profited through the services of a special taxidermist, Mr. I. S. Reiff, who has, with a fair amount of care, examined the greater number of the 30,000 birds in the collection, applying arsenical poisoning and insect-powder where necessary, and readjusting the plumage of partially mutilated specimens. The total number of birds marked out as no longer serviceable for museum purposes is some 12 or 13, a very insignificant number when the extent of the collection is taken into account, and when it is remembered that this represents a destruction, not only for a single year, but for several years past. The immunity from insect depredations is not a little remarkable, seeing how imperfect the ornithological cases appear to be in comparison with those which more modern methods have succeeded in producing. An application of pure naphthaline in cores will be attempted this year as a further preventive of destruction. The following list indicates the species of birds which have been removed

from the cases as above stated: *Treron aromatica* (Java), *Treron aromatica* (*Ambunensis*, Java), *Chasmarhynchus variegatus* (Brazil), *Pitta cœrulia* (Java), *Cassicus hæmorrhous* (S. Amer.), *Alcopus picoides* (East Indies), *Turdus* sp.? (New Jersey), *Thryothrus luscinia*, *Icterus Girardii* (Guatemala), undet. (East Indies), and *Spermestes Poensis* (Fernando Po).

The Ornithological department has recevied valuable and extensive accessions during the year, the more important being a collection of skins from the collection of Dr. H. B. Butcher, presented in the name of J. Dickinson Sergeant, and a like collection presented by Dr. W. L. Abbott of this city. The latter, consisting principally of birds of the United States, the West India Islands, and South and Central America, is estimated to number between two and three thousand skins, mostly in a very good state of preservation. These, for want of space-room, have not yet been definitely located, and it is imperative that some immediate provision be made for their safe-keeping.

To the departments of Geology, Mineralogy and Paleontology there have been a number of additions, in the main of no very great importance, except in so far as pertains to the specimens purchased by the Wm. S. Vaux fund. These are referred to in the report of the special conservator, herewith appended. The extensive collections of Florida fossils and rocks, which were obtained in the early part of last year, and which, for want of case room, had been, during study, temporarily deposited in the room properly belonging to Archæology and Ethnology, are now in a condition to be placed in their proper position, a number (10) of new cases having recently been added to the main floor. By their addition the collection of tertiary invertebrate fossils of the Academy becomes by far the most important of any in the country, and falls probably but little below that of any in the world. Valuable accessions to the paleontological collections are an almost complete skull, leg bones, ribs, etc., of a Mastodon, found near Pemberton, N. J., which were generously donated to the institution by J. Coleman Saltar, of Pemberton, and Emlen McConnell, of Philadelphia, two young students of geology who first called attention to the interesting find. This is the most perfect specimen of the animal that has been found in the State during a period of some forty years.

There have been but few additions to the department of Archæology, and attention is called to the report of the Professor of

Ethnology and Archæology, who deplores that for want of room he should be compelled to decline donations to this section of his department. The condition of overcrowding is, unfortunately, only too true for almost all the other departments, and the necessity for an extension to the present building becomes more pressing every day. Unless assistance is rendered in this direction the collections of the Academy, which are of their kind probably still the most extensive and important in the country, must cease to grow. An appeal to the Legislature of the State, made in the early part of the year, for aid in constructing an annex in which to exhibit the natural history resources of the State of Pennsylvania and the extensive collection of the State Geological Survey—deposited in the cellar of the Academy—was favorably reported upon in Committee, but failed of its purpose by reason of a design to construct a Survey Museum in the State Capital. The encouragement and endorsement which the Academy's petition met from many of the most influential citizens of Pennsylvania—Congressional representatives, merchants, manufacturers, and those most interested in the development of the natural history resources of the State—lead to the hope that at no very distant day that assistance may be obtained which has so long been needed. In the meantime it is earnestly to be hoped that he patriotic instincts of the citizens of Philadelphia will generously assert themselves, and not allow that institution to go in want which has cast so much lustre, not only upon the science of the city, but upon the science of the whole country.

In its educational workings the Academy is doing much good. The museum has been thrown open free to the classes of all institutions of learning, and the collections are largely made use of by schools both in and out of the city. The attendance at the class lectures, as well as participation in the field-excursions in connection with these, is also considerable, and shows that the facilities for study and work afforded by the Academy are largely appreciated. The course of popular evening lectures which, on the recommendation of the professors, and with the approval of the Council, was inaugurated in the spring of last year, has proved successful beyond expectation, and has led to the preparation of a more extended course, now in process of execution. Unfortunately, the hall of the Academy is not well suited to the delivery of lectures to large audiences, and hence no absolute satisfaction can be given to a large proportion of the listeners. But the character of the attendance speaks well for the interest in the work.

In connection with the work of facilitating study in the several departments of natural history, the Curator-in-Charge desires to call attention to a synoptic collection of minerals, rocks, and fossils, which has been arranged on the main floor as a practical key or guide to geological inquiry and to the various text-books that have been prepared upon the subject. The arrangement of the collection, which is contained in ten table-cases, is approximately as follows: rock-forming minerals, accessory minerals in rocks, ores, rocks proper, rock-structures, distinctive groups of fossils, and the genera of recent shells. It is thought that through a collection of this kind much valuable assistance can be given to the student, to whom the large general collections of the Academy can be of but little service.

Specimens for study have during the year been loaned to Profs. Scott and Osborn, of Princeton, N. J., Prof. R. P. Whitfield, of New York, and Prof. O. C. Marsh, of New Haven.

In conclusion, the Curator-in-Charge desires to call attention to three pressing wants of the Academy: 1. The absolute need of an extension to the present building, wherein to store the rapidly increasing collections, and to accommodate the material already in possession that can no longer find proper place for exhibition. 2. An amphitheatre or lecture-hall suitable for large audiences; and 3. A museum fund, wherewith to purchase such needed specimens for the Museum as do not come in the regular way of donation. It is also earnestly recommended that some provision be made toward permitting access to the Museum on Sundays. It cannot be denied that a large part of the population of our city is debarred from the advantages offered by the Academy by reason of the institution being closed on the only day which is free to the artisan, merchant or mechanic. Complaint in this regard is frequently made, and it is much to be wished that the Academy may at an early day meet the generous demand that is made upon it. The additional expense that would be entailed upon the institution through such opening, while beyond the resources available at present, must necessarily be slight, and it is but fair to assume that such assistance might be obtained as will permit of the project being carried into execution.

Very respectfully,

ANGELO HEILPRIN,
Curator-in-Charge.

JOSEPH LEIDY,
Ch'n Curators.

REPORT OF THE CURATOR OF THE WILLIAM S. VAUX COLLECTIONS.

The Curator of the William S. Vaux collections respectfully submits his fifth annual report to the Council of the Academy:—

The collections are in good order and condition. No change has been made since the report of 1886, except such as would necessarily result from the introduction of the new specimens added to the collections.

During the year 156 specimens were purchased at a cost of $638.00. To accommodate the increase, $44.60 have been expended for two new cases.

The collections consist at present as follows:—

Number of mineral specimens as per report of 1886,	6,630
Purchased during the year ending November 30,	156
Total,	6,786
Archæological specimens (same as reported in 1886),	2,940

The growth of the collections since they came into the Academy's possession has been as follows:—

Specimens purchased in 1884,	60
Specimens purchased in 1885,	104
Specimens purchased in 1886,	114
Specimens purchased in 1887,	156
Total,	434

The aggregate cost of these has been . . . $2086.70

Among those purchased during the present year most worthy of special notice may be mentioned a Stalagmite of Aragonite. This specimen measures 4 ft. 4 in. in height, and weighs about 100 pounds. It was taken from a cavern in the Organ Mountain, New Mexico, and is believed to be an unusually fine example of stalagmitic formation. Other interesting specimens are a fine group of Rutiles from Georgia, remarkable for their high lustre and sharp angles of crystallization; a large specimen of Wulfenite from Arizona, the stone matrix of which is 6 by 8 inches, coated over with beautiful red translucent crystals of Molybdate of lead; a large specimen of Stibnite from Japan, weighing 125 pounds, consisting of a group of

70 or 80 well terminated crystals of Antimony Sulphide, with beautiful modifications; and several specimens of Azurite and Malachite from Arizona.

Respectfully submitted,

JACOB BINDER,

Curator.

REPORT OF THE BIOLOGICAL AND MICROSCOPICAL SECTION.

During the year 17 stated meetings were held with an average attendance of 10 members.

The Annual Exhibition was held Dec. 9th, 1886 with the usual success.

One member and eight contributors were elected during the year.

The deaths of Dr. N. A. Randolph and of Paul P. Keller were announced.

The following are the more important subjects under discussion during the year:—

December 6, 1886. Recent advances in Embryology, by Prof. J. A. Ryder.

December 6, 1886. Fructification in the Algae, by Dr. L. Brewer Hall.

January 3, 1887. Observations upon Trichia scabra, by Harold Wingate.

January 3, 1887. Demonstration of Prof. Ryder's ribbon cutting Microtome.

January 17, 1887. Observations upon the eggs of the Skate, by Prof. J. A. Ryder.

February 9, 1887. Upon the best methods of making Cells, by Dr. L. Ashley Faught.

February 9, 1887. The blastodermic layers in the yolk of different animals, by Prof. J. A. Ryder.

February 21, 1887. The hairs and spines of Onosmodium Virginiana and other plants, by Dr. J. B. Brinton.

February 21, 1887. Experiments with the moth larva in reference to the manner in which they injure wood fibres, by George B. Cock.

March 7, 1887. Experiments with the moth larva and Cockroach with referrence to the manner in which they injure wool fibres, by George B. Cock.

April 4, 1887, Upon the anatomy of the sexual apparatus of the Bee, by Prof. J. A. Ryder.

April 4, 1887. Description of a new Microtome for making large sections of the brain etc., by Prof. J. A. Ryder.

April 18, 1887. The hearing organ of Mysis flexuosa, by by Harold Wingate.

April 18, 1887. Hemiarcyria serpula, by Dr. George A. Rex.

April 18, 1887. Structure of the leaf of Deutzia, by Dr. J. B. Brinton.

April 18, 1887. Anatomy of the leg of the Honey Bee, by Dr. L. Brewer Hall.

April 18, 1887. The making of wax cells, by John C. Wilson.

June 6, 1887. Karyokinesis, by Prof. J. A. Ryder.

September 19, 1887. The evolution of an eight-limbed vertebrate, by Prof. J. A. Ryder.

September 19, 1887. The warts upon the legs of the Horse, by Prof. Harrison Allen.

October 3, 1887. The development of the ovum in the Field Mouse, by Prof. J. A. Ryder.

October 17, 1887. Placentation in animals, by Prof. J. A. Ryder.

On October 17, a course of lectures to be delivered during the winter was arranged by the lecture committee. The first one by Prof. J. A. Ryder upon "The two great Plans of Animal Organization" was given in the hall of the Academy Monday, November 21, 1887.

Very respectfully,

ROBERT J. HESS,

Recorder.

REPORT OF THE CONCHOLOGICAL SECTION.

The Recorder of the Conchological Section respectfully reports that during the year past, such Conchological papers as have been accepted have been published by the Academy as heretofore.

The Section has lost by death, one member, Isaac Lea, LL. D. who died in last December at the advanced age of ninety four years. At a special meeting of the section held Dec. 14th, 1886 the following minute was adopted and by direction transmitted to his family.

"The Republic of Natural Sciences has lost a generous friend and an efficient workman by the death of Dr. Isaac Lea. His services to the Academy of Natural Sciences of Philadelphia, have extended through seventy-one years from June 1815. He was one of the founders of the Conchological Section, Dec. 1866, and was its first Director. During a period of over fifty years he gave his time and talents, his labor, influence and money in aiding the progress of Conchology in its several departments and especially in that of the fresh water mollusks. In this he was leader and master, and among the first in authority. His name is conspicuous wherever Conchology is studied on account of the valuable services he has rendered in this department of the Natural Sciences.

His happy life was prolonged far beyond the common lot. We sincerely deplore his loss. Our sympathies are with his family. We place this record on our minutes in testimony of our sense of his high and in every respect exemplary character and conduct."

Mr. G. W. Tryon Jr., Conservator, reports as follows:—

"The presentation by Mrs. Susan D. Brown of Princeton N. J., of the extensive and valuable collection of pulmoniferous land shells made by her late son Albert D. Brown is the principal event in the history of our section during the year. Mr. Brown, a well known conchologist and one of the founders of this Section, by devoting his attention to a single great group of the mollusca succeeded in amassing a collection which, for the completeness of its suites and beauty of arrangement ranked easily among the best in the world. His mother, anxious to place these treasures where they would be most useful, offered them to us subject to no restriction whatever.

Upon consideration of the extent and condition of the collection, your conservator decided that no portion of the mounted series should be excluded from our cases; for although we already possessed a large proportion of the species, the localities were in most cases different, and the specimens frequently much finer than ours. Hundreds of the species were, however, new to us. The mounting and labelling of the Brown shells was confided to Mr. Frank Stout, and this duty, which has occupied his time for the major portion of the year, has been very acceptably performed. The collection numbers 5404 trays and labels, containing 19,593 specimens. Mrs. Brown also presented the fine microscope used by her late son. A suitable inscription has been engraved upon this instrument, which is intended for the use of members of the section and conchological students generally.

Other important accessions include suites of the land shells of China from B. Schmacker and Rev. M. Heude, those from the latter being a set of his types, a collection of Philippine and two of Polynesian shells obtained by purchase, a series of the shells dredged in southern American waters by Dr. Wm. H. Rush, U. S. N. including a number of recently described new species, a collection from Canton, Ills. from J. Wolf, and a large collection of Iowa shells from B. Shimek. Our American suites have continued to be enriched, as heretofore, by the gifts of numerous friends. In all 47 additions from 31 sources have been made aggregating 739 lots and 3699 specimens (see Additions to Museum.) These have all been labelled and are incorporated in the collection which now embraces 51,327 trays and labels and 189,150 specimens."

Five members and fourteen Correspondents have been elected during the year.

No changes have been made in the By-Laws of the section.

The officers for 1888 are:—

Director, ...	W. S. W. Ruschenberger.
Vice-Director, . . .	John Ford.
Recorder, ...	S. Raymond Roberts.
Secretary, ...	John H. Redfield.
Treasurer, ...	Wm. L. Mactier.
Librarian, ...	Edward J. Nolan.
Conservator, . . .	Geo. W. Tryon, Jr.

Respectfully submitted,

S. RAYMOND ROBERTS,

Recorder.

REPORT OF THE ENTOMOLOGICAL SECTION.

The Recorder of the Entomological Section, would state that the year now closing, has been one of advanced success. The meetings have shown a marked improvement in the attendance of the members, also in the increased interest in the proceedings.

Much valuable information to Entomologists has been given, through the remarks and addresses made by those present. Dr. Horn has especially studied to assist all who were interested in the special branch of Coleoptera. The section has held seven meetings in the year, at which various entomological matters have been discussed.

The American Entomological Society has been able during the year to publish about 225 pages of its Transactions, and in addition thereto has issued a supplementary volume, containing 351 pages, making a total amount of about 575 pages of printed matter issued.

The collections have been cared for by the custodian and curator, and are in a remarkably good condition.

The following are the officers elected for the ensuing year.

Director, ... Geo. H. Horn, M. D.
Vice-Director, ... Rev. H. C. McCook, D. D.
Recorder, ... J. H. Ridings.
Treasurer, ... E. T. Cresson.

Respectfully submitted,

J. H. Ridings,
Recorder.

REPORT OF THE BOTANICAL SECTION.

The Botanical Section respectfully reports that at the annual election for the coming year, the following officers were elected:—

Director, ... Dr. W. S. W. Ruschenberger.
Vice-Director, . . . Thomas Meehan.
Recorder, ... Dr. Charles Schaffer.
Cor. Secretary and Treasurer, . Isaac C. Martindale.
Conservator, ... John H. Redfield.

The Section is out of debt and has a balance with its Treasurer.

The meetings have been held regularly on the appointed evenings, with a full average attendance, and honored at times by distinguished visitors. At every meeting communications have been received and discussed, and some of the more important have been printed in the Proceedings of the Academy.

The Herbarium continues the encouraging growth reported for several years, the past year being perhaps still more encouraging than the others. Through the attention of the Conservator, John H. Redfield, aided by Mr. Burk, everything is distributed as fast as received, and the record shows that the collection now embraces of flowering plants and ferns a total of 27,267 species out of a possible 100,000 known to Botanists. 1078 were new additions of the past season.

The Conservator's account of our progress in detail is attached as part of this report.

Respectfully submitted,

THOMAS MEEHAN,

Vice-Director.

Conservator's Report for 1887.—The Conservator of the Botanical Section reports that the donations to the Herbarium during the year closing December 12th, are estimated to be 7921 species, of which 2245 are Phanerogams and Ferns, 5601 are Fungi and 75 are Lichens. Of the 2245 species of phanerogamic plants and ferns, 1078 are believed to be new to our collection, 98 of them representing new genera. 1099 are North American, 611 are from Mexico and South America, 64 are from the Eastern Continent and 471 are Australian. What portion of the Fungi may be new to the collection cannot be estimated until the completion of the catalogue of this Order now in progress.

For the principal part of the large additions to the Academy's collection of Fungi, we are indebted to Mrs. Anna T. Martin, widow of the late Dr. Geo. Martin of West Chester, who has presented to us the entire collection made by her husband, consisting of 4040 specimens neatly mounted in pockets and placed in boxes, and all numbered to correspond with MSS. catalogues accompanying. These were mostly collected by Ravenel, Rehm, Kunze, Rabenhorst, and Winter and by Dr. Martin himself. The donation also included Centuries I to XVII of Ellis' North American Fungi, of which 15 Centuries are duplicates to those possessed by us. Drs. Rex and Wingate have also kindly presented Centuries XVIII and XIX of the same series making it complete to the present time. These important additions taken in connection with the earlier collections of Schweinitz, Ravenel, Michener and others, make this department of our Herbarium of unusual value, and call for thorough re-arrangement and critical examination of our material and the preparation of such a catalogue of our Fungi, as shall make the whole readily accessible and useful to students. This task has, by the Section, been committed to Messrs. Stevenson, Rex, Brinton and Wingate, and we may hope it will be completed within another year.

The number of species of phanerogams and ferns, represented in our Herbarium at date of last report, was 26,189
to which add the estimated accessions of the past year . 1,078
and we have the estimated present total 27,267

Among the additions of the past year worthy of special notice are the following, for which we are indebted to members of the Section:—four remittances from Baron F. von Müller of Melbourne, Australia, through Mr. Meehan, containing 471 species of Australian plants, of which 310 are new to the collection, 52 of them representing new genera:—a collection made by Dr. Palmer in the Mexican State of Jalisco, in 1886, embracing 510 species, of which one-half were new to us:—and a first instalment of the plants collected by N. N. Rusby in Chili, Bolivia and Brazil in 1885 and 1886, consisting of about 450 species. Most of the latter are yet undetermined except as to genus, but it is estimated that about one-half are new to us, many of them being yet undescribed.

The time and labor required for the proper care of the new additions and for their incorporation into the Herbarium, have somewhat retarded the work of mounting the North American portion of it, nevertheless material progress has been made. All of the Polypetalous and Monopetalous orders are now mounted and some portions of the remainder, leaving less than one-fourth of the work yet unaccomplished. In all the work that has been performed, the Conservator has been greatly aided by the efficient services of Mr. Isaac Burk.

In order to provide space for the Martin collection of Fungi, it became absolutely necessary to make some disposal of a large amount of duplicate plants, which had been gradually accumulating through a long period of years, many of them of considerable value, others in bad condition. These by vote of the Section, have been sent to Bryn Mawr College on terms believed to be mutually advantageous, and the proceeds will be used for the increase of the Herbarium.

A complete list of the additions accompanies this report, and will appear in its proper place, under the head of "Additions to the Museum."

Respectfully submitted,

JOHN. H. REDFIELD,

Conservator.

REPORT OF THE MINERALOGICAL AND GEOLOGICAL SECTION.

The Mineralogical and Geological Section would respectfully report to the Academy, that a number of meetings have been held

during the year, but that owing to absence of members and other causes, the attendance and interest has not been as great as in former years, nor have the additions to the collections been as large, excepting those to the Vaux collection.

It would also report that the officers elected for the ensuing year, are as follows:

Director,	Theo. D. Rand.
Vice-Director,	W. W. Jefferis.
Recorder and *Secretary*,	Charles Scäffer.
Treasurer,	John Ford.
Conservator,	W. W. Jefferis.

Respectfully submitted,

THEO. D. RAND,
Director.

CHAS. SCHAFFER,
Recorder.

REPORT OF THE PROFESSOR OF INVERTEBRATE PALEONTOLOGY.

The Professor of Invertebrate Paleontology respectfully reports that during the year he has conducted a course of practical instruction in geology and paleontology, the course comprising some twenty-five lectures in the class-room and nine field demonstrations. The attendance in the lecture-room was about forty, and in the field thirty or more. Much good work was done in the field, the two excursions to the marl diggings in the southern part of New Jersey, adding considerably to our knowledge of the Tertiary fauna of the State. Thirty species not hitherto recorded had been identified, and three new forms determined. The existence of the Newer Miocene deposits had also been determined by one of the members of the class, Mr. Lewis Woolman, who has published a paper on the subject in the Proceedings of the Academy. The undersigned has likewise prepared a paper upon the New Jersey Miocene fauna, giving a complete list of the Miocene Molluscan species known to date. The excursion supplementary to the general course, extended over a period of nineteen days, comprising the region between the Delaware Water Gap and the Catskill Mts., and was participated in by fifteen students.

The collections in the department of Invertebrate Paleontology have received a number of accessions during the year, but none of very great importance. Attention is called in the report of the Curators to the addition of a number of new cases to the main floor of the Museum, which will now permit of the definite location of the Academy's share of the extensive series of fossils collected in Florida in the early part of last year, and which, during study, had been temporarily deposited in the room pertaining to Ethnology and Archæology. The arrangement of a synoptic geological and paleontological collection, designed as a "key" or *practical* manual for the student, is also indicated in the Curator's report.

The collections in general have been studied by a number ot students from the city schools, and material from them has been sent to Prof. R. P. Whitfield, of New York, to assist in the preparation of an extensive work on the fossil invertebrate fauna of the State of New Jersey.

Very respectfully,

ANGELO HEILPRIN,

Prof. of Invertebrate Paleontology.

REPORT OF THE PROFESSOR OF INVERTEBRATE ZOOLOGY.

The Professor of Invertebrate Zoology respectfully reports, that during the past year he has delivered a series of ten lectures on the "Sense Organs in the Animal Kingdom," besides having conducted a class in animal dissection during the spring months. In the autumn he inaugurated a class in practical comparative histology, which at present numbers six students, meeting once a week, on Saturdays.

A course of some five lectures is intended to be given during January and February of the coming year, on "Certain Chapters in Zoological Philosophy."

The additions to the Museum have not been very numerous nor especially important, although comprising a number of interesting forms that have been heretofore wanting. Much improvement has been made by the Curator-in-Charge, in the more systematic

arrangement of the collections, and it is hoped in a very short time a regular zoological sequence may be established.

Very respectfully,

BENJAMIN SHARP,

Professor of Invertebrate Zoology.

REPORT OF THE PROFESSOR OF MINERALOGY.

The Professor of Mineralogy respectfully reports that since his last published report he has delivered in the Hall of the Academy a course of twenty-five lectures on Mineralogy, to a class of some thirty persons. Field excursions and lectures in the neighborhood of the city were given, as well as practical instruction in the laboratory of the Academy. During the past two years no lectures were given on account of absence in Europe, the undersigned being engaged during the winters in petrological studies at the University of Heidelberg, and during the summers at geological researches in Great Britain and on the continent. It is intended to deliver a course of illustrated lectures upon Microscopical Petrology during the present winter.

As shown by the accompanying report of the Curators, the mineralogical collection of the Academy has been enriched by a number of valuable additions.

Respectfully submitted,

H. CARVILL LEWIS,

Professor of Mineralogy.

REPORT OF THE PROFESSOR OF ETHNOLOGY AND ARCHÆOLOGY.

During the past year a private course of six lectures were delivered by me on Anthropology and several on Archæology in the popular course. They were well attended, and there have been many indications that these subjects and those of pre-historic man and Ethnology, which are properly branches of it, are exciting more and more attention, both in the American scientific world at large and particularly in this community and among members of the Academy.

The proposition has been urged by several members that a section be formed especially devoted to these studies. If the time is not already ripe for this, it undoubtedly will be soon.

In my last report, the attention of the Academy was called to the insufficient accommodations now provided for the Archæological and Ethnological collections of the Academy, and a resolution was passed asking more specific statements on this point. The facts are these: The present collection is scattered throughout the building, portions of it being in every room where there are any collections at all. Many of the objects are crowded together in space too restricted to allow of their proper display. Many have to be stored away in drawers or closed cases where the public or even students can derive no advantage from them whatever. It has been found impossible to arrange them in any satisfactory manner. In order to accomplish this a much larger space should be assigned this branch than it now occupies, and all the objects properly belonging to it should be collected and disposed in the most illustrative manner. The plan of such an arrangement should be distinctly the Ethnological plan, not that adopted in the National Museum at Washington, which for scientific purposes is the worst conceivable.

A great advantage which such increased space and scientific display would have would be to render manifest in what departments of anthropology the Academy is deficient, and would stimulate members and their friends to supply such deficiencies. This would not be difficult to accomplish. On several occasions gentlemen have offered excellent collections either for gift or for deposit in the Academy, provided we could give them fair space for display. I have felt obliged to decline such offers as I knew that with the space at my command it was not possible to satisfy the reasonable expectations of the donors.

The additions during the year to the department under my charge have neither been numerous nor specially important, the most noteworthy being a collection of Peruvian mummies and crania, presented by Messrs. G. Y. and W. H. McCracken.

Respectfully submittrd,

D. G. Brinton,

Professor of Ethnology and Archæology.

SUMMARY OF THE REPORT OF WM. C. HENSZEY, TREASURER,

For the Year Ending Nov. 30, 1887.

Dr.

To	Initiation Fees	$110 00	
"	Contributions (semi-annual)	1589 16	
"	Life Memberships	100 00	
"	Admissions to Museum	292 95	
"	Publication Committee—Sales of Proceedings, Journal, etc	504 12	
"	Microscopical and Biological Section—Donation	50 00	
"	State Tax on Mortgages	113 10	
"	Miscellaneous	16 40	
"	Lecture Fees	370 75	
"	Estate Isaac Lee dec'd., Contribution for Dr. Genth's plates	96 50	
"	Duplicate Books	1 25	
"	Interest on Investments	2306 83	
"	Interest on Money awaiting Investment	1097 13	
"	Rentals from Real Estate	1859 33	
"	Wilson Fund, toward Salary of Librarian	300 00	
"	Investment Fund, amt. transferred	4000 00	
"	Museum Fund, amt. transferred	105 00	
			$12912 52

Cr.

By	Balance overdrawn from last account	$1237 92	
"	Salaries, Janitors, etc	3403 56	
"	Printing and Binding Proceedings, etc	707 85	
"	Printing and Stationery	294 71	
"	Repairs	450 92	
"	Plates and Engravings	242 10	
"	Gas	94 29	
"	Postage	180 54	
"	Coal	367 50	
"	Cards, Trays and Boxes	139 08	
"	Insurance	55 00	
"	Books	18 00	
"	State Taxes on Mortgage Investments	122 85	
"	Water Rents	30 50	
"	Miscellaneous	910 88	
"	Vials	29 75	
"	Mounting Specimens	49 10	
"	Lecture Fees paid to Professors	307 27	
"	Cases and Drawers	571 25	
"	Taxes and Water Rents 1887, Real Estate	338 85	
"	Repairs and Expenses, Real Estate	1253 04	
"	Life Memberships transferred to Investment Fund	100 00	
			10904 96
	Balance		$2007 56

I. V. WILLIAMSON LIBRARY FUND

Investment Fund, amt. transferred		$1750 00
Books		1516 40
Repairs to Houses		389 14
Taxes and Water Rents		194 93
Binding		97 95
Collecting		83 35
		$4031 77
Balance per last statement	$2023 58	
Rents Collected	1003 50	
Ground Rents Collected	697 09	
		3724 17
Balance overdrawn		$ 307 60

THOMAS B. WILSON LIBRARY FUND.

Balance overdrawn as per last statement	$ 147 08
Books	117 61
Binding	18 00
Cash transferred to General Account toward Salary of Librarian,	300 00
	$ 582 69
Less Income from Investments	525 00
Balance overdrawn	$ 57 69

JESSUP FUND. (For Assistance of Students.)

Interest on Investments		$ 560 00
Balance overdrawn per last statement	99	
Disbursements	271 00	
		271 99
Balance		$ 288 01

WM. S. VAUX FUND.

Balance per last statement	$ 512 54
Interest on Investments	600 00
	$1112 54
Cash paid for Minerals	793 25
Balance	$ 319 29

There is now a balance in the Investment Fund of twenty three thousand one hundred and forty nine dollars $\frac{76}{100}$ to be invested.

The election of Officers, Councillors and Members of the Finance Committee, to serve during 1888, was held, with the following result.

President, . . .	Joseph Leidy, M. D.
Vice-Presidents, . .	Thomas Meehan,
	Rev. Henry C. McCook, D. D.
Recording Secretary, .	Edward J. Nolan, M. D.
Corresponding Secretary,	George H. Horn, M. D.
Treasurer, . . .	William C. Henszey.
Librarian, . . .	Edward J. Nolan, M. D.
Curators, . . .	Joseph Leidy, M. D.
	Jacob Binder,
	W. S. W. Ruschenberger, M. D.
	Angelo Heilprin.
Councillors to serve three years, ...	Charles P. Perot,
	John H. Redfield,
	S. Fisher Corlies,
	Charles Morris.
Finance Committee, .	Isaac C. Martindale,
	Aubrey H. Smith,
	S. Fisher Corlies,
	George Y. Shoemaker,
	William W. Jefferis.

ELECTIONS DURING 1887.

MEMBERS.

January 25.—William Osler, M. D., Bernard Persh, Geo. B. Cresson, Joseph Whitehouse, William B. Marshall.

March 29.—Albert W. Vail, Richard B. Westbrook, William P. Wilson, George O. Praetorius, William Blasius.

June 28.—Theodore Wernwag.

August 30.—Harold Wingate.

October 25.—Craig D. Ritchie.

November 29.—Miss Mary E. Schively, Gavin W. Hart, Rev. R. H. Fulton, D. D., Charles A. Davis, D. D. S.

CORRESPONDENTS.

March 29.—W. K. Brooks of Baltimore, Md.

May 31.—Henry A. Ward of Rochester, Addison E. Verrill of New Haven, R. P. Whitefield of New York, Edgar A. Smith of

London, August Brot of Geneva, E. Ray Lankester of London, William E. Hoyle of Edinburgh,, Edward Von Martens of Berlin, William Kobelt of Schwanheim, S. Clesson of Ochsenfurt, Rev. M. Heude S. J.[1] of Zika-Wei, Rudolph Berg of Copenhagen, A. S. de Rochebrune of Paris, Herman Friele of Bergen.

November 29.—Orville A. Derby of Rio de Janeiro.

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[1] Declines election.

ADDITIONS TO THE MUSEUM.

1887.

ETHNOLOGY AND ARCHÆOLOGY.

M. Sommerville. Indian implement, Northampton Co., Pa.
J. W. Brown. Aboriginal axe (locality unknown).
W. R. D. Blackwood. Aboriginal club, South Sea Islands.
A. M. Parsons. Aztec skull, from City of Mexico.
Mrs. W. Lorenz. Aboriginal celts and copper implements, from Peru.
C. R. Bee. Spaniard's skull.
E. T. Ingram. Aboriginal implements from Cope's Mills, near West Chester, Pa.

MAMMALIA.

Zoological Society of Philadelphia. *Petrogale penicillatus*, Australia; *Hippopotamus amphibius; Echidna hystrix; Ovis tragelaphus* (Atlas Mts.); *Macropus giganteus* (Australia). Wombat; black leopard.
Smithsonian Institution. Skeleton and hide of bison.
Academy of Natural Sciences (purchased). Skeleton of bison.
Frank Thomson. Head of bison.

BIRDS.

J. Dickinson Sergeant. 297 North American birds collected by A. B. Butcher.
Zoological Society of Philadelphia. *Cacatua sulfurea; Cacatua galerita; Crax Daubentoni*, Brazil.
W. L. Abbott. Collection of between 2000 and 3000 bird-skins, mainly North American.
P. Schoenberg. *Diomedea exulans* and *Puffinus melanurus*, from the S. W. coast of South America.

REPTILES.

H. C. Young. 33 specimens of *Tropidonothus sipedon*, taken from a female shot near Salem, N. J.

FISHES.

J. Binder. *Chilomycterus turgidus*, from Atlantic City, N. J.

VERTEBRATA (Fossil).

Thomas Hockley. *Carcharodon Melegadon* (tooth), S. Carolina.
B. L. Fetherolf. Amphibian foot-print, Carboniferous of Barnesville, Pa.
L. Woolman. *Rhizodus* (scale), Carboniferous of Mazon Creek, Ill.
J. C. Saltar and Emlen McConnell. Skull, leg-bones, etc., of Mastodon, found near Pemberton, New Jersey.

MOLLUSCA.

W. G. Binney. Seven species of American land shells. (Types.) *Helix æstata*, Bourg., Algeria.
E. T. Brown. *Buccinum undatum*, egg capsule, Nahant, Mass.
J. J. Brown. *Unio Canadensis* and *Anodonta Benedictii*, from Wisconsin.
Mrs. S. D. Brown. The A. D. Brown collection of pulmoniferous land shells 5404 trays, containing 19,593 specimens. A fine microscope with complete fittings.
S. E. Caldwell. *Unio complanatus*, Nova Scotia.
H. C. Chapman. Four species marine shells from Bar Harbor, Maine; *Terebratulina septentionalis*, Bar Harbor, Maine.

Conchological Section. Ninety-five species (types) of Chinese land shells, described by Rev. M. Heude. *Modiola capax*, Gulf of California; Eighty-five trays, land, fresh water and marine shells from the Philippine Islands; Sixty-six trays Polynesian shells (from Andrew Garrett, Society Islands); Forty-seven trays marine shells from Southern coast U. S. and West Indies collected by W. H. Rush, M. D.

Rev. A. Dean. Twelve trays Unionidæ; Seven trays fresh-water shells, from Alabama.

Miss A. M. Fielde. *Cerithium microptera* and *Onchidium Typhæ*, Swatow, China.

F. J. Ford. *Unio Popenoei*, Kansas.

J. Ford. *Patella tramoserica*, *Lunatia plumbea*, from Australia; *Tellina radiata*, Barbadoes.

A. Garrett. Five species Indo-Pacific shells.

C. N. Johnson. Six species of Florida shells.

E. A. Kelley. *Ariolimax Californicus*, Napa Co., California.

Joseph Leidy, M. D. *Conus suffusus*, New Caledonia; *Helix cellaria*, Horticultural Hall, Philadelphia.

W. B. Marshall. Three species of fresh-water shells, from Albany, New York.

Oberlin College. *Planorbis campanulatus*, Ohio.

C. R. Orcutt. *Olivella zonalis*, La Paz, L. California.

P. Ruggles. Two species of *Pisidium*, from Connecticut.

B. Schmacker in exchange. One hundred and nine trays land, fresh-water and marine shells from China.

Miss E. H. Schofield. *Goniobasis symmetrica*, Cold Creek, N. C., 4000 ft. altitude.

Benjamin Sharp. Eighteen trays European land, fresh-water and marine shells.

B. Shimck. One hundred and twenty-two trays land and fresh-water shells from Iowa.

C. T. Simpson. Eleven trays Honduras shells.

W. W. Westgate. *Unio glebulus*, Buffalo Bayou, near Houston, Texas.

J. Willcox. Nine trays marine shells from Charlotte Harbor and Sarrasota Bay, Florida; *Melongena corona*, W. coast of Florida; *Yoldia thraciæformis*, off Halifax, N. S.

J. Wolf. Thirty four trays land and fresh-water shells, from Canton, Illinois.

INVERTEBRATA (recent) excluding Mollusca.

W. W. Jefferis. Coral (undetermined), from the Bahamas; *Brissus pectoralis* (Bahamas); sponge (undetermined), Bahamas; *Ctenactis echinata*, Red Sea; trap of trap-door spider, California; *Porites conglomerata*, Red Sea; *Herpetolitha limax*, Indian Ocean; seven specimens of sponges (Bahamas?)

H. C. Chapman *Chalina oculata*, *Phakellia ventilabrum*, *Hymeniacidon ficus* (sponges), *Boltenia reniformis*, *Actinia* (sp.?), *Asterias Forbesii*, *Aphrodite* (sp.?), from Mt. Desert; *Scolopendra*, from Brazil; *Physalia pelagica*, Bahamas.

H. C. Chapman. Collection of invertebrates from Mt. Desert.

Joseph Walton. *Paractis rapiformis*, from Atlantic City, N. J.; *Squilla mantis*.

Joseph Willcox. Sponges, from west coast of Florida.

John Ford. *Serpula* with *Eschara*, Atlantic City, New Jersey.

H. A. Ward. *Verrilia Blakei* (two specimens), from San Juan de Fuca.

W. S. Jones. *Hippa* (sp.?), from Panama.

A. Partridge. *Tænia saginata*.

I. C. Martindale. *Flustra foliacea*, from England.

J. H. Redfield. *Spirorbis nautiloides*, from Bar Harbor, Maine.

INVERTEBRATA (Fossil).

Thomas Hockley. *Favosites Gothlandica*, *Halysites catenulata*, and Crinoid-stems, from the Silurian of Norway.

E. P. Boshart. *Lithostrotion* from Lewis Co., New York.

L. Woolman. *Acanthotelson Stimpsoni*, *Acanthotelson* (sp. ?). *Palæocaris typus*, from the Carboniferous of Mazon Creek, Ill.

Joseph Willcox. Thirteen trays of Tertiary fossils from Florida.

Conchological Section A. N. S. One hundred and forty five trays Miocene fossils from the Touraine (collected by G. Dollfus.)

PLANTS (Recent).

Baron F. von Müller, Melbourne, Australia; through Thomas Meehan, 471 species Australian plants, mostly new to the collection.

Prof. C. S. Sargent. *Myginda integrifolia*, *Cratægus berberidifolia*, *Eugenia monticola*, *Drypetes glauca*, from Florida and Louisiana.

J. Donnell Smith. *Halesia parviflora*, from Florida.

Prof. Thomas C. Porter. *Rhizomorpha subcorticale ?* a fungus attached to timbers, Dickinson Iron Mines, 750 feet below the surface; 16 species of Pennsylvania plants.

Prof. N. L. Britton. of Torrey Herbarium, N. Y. 14 species of North American *Cyperaceæ; Houstonia Croftiæ*, new species from Texas.

Isaac Burk. 22 species plants from vicinity of Richmond, Va.; 20 species plants from ballast grounds, Philadelphia and Camden; 5 species plants cultivated in Horticultural Grounds, Fairmount Park.

Mrs. Anna T. Martin, widow of Dr. Geo. Martin. The extensive collection of Fungi made by Dr. Martin, all neatly mounted in pockets, numbered to correspond with catalogues accompanying; contained in 96 boxes, comprising 4040 specimens, and representing probably 3700 species; also 17 Centuries of Ellis' North American Fungi.

Drs. Geo. A. Rex and Dr. H. Wingate. 18th and 19th Centuries of Ellis' North American Fungi, making the series complete to this date.

Miss Adele M. Fielde, Swatow, China. Flowering and leafy shoots and cones of *Cunninghamia Sinensis* and *Pinus Sinensis*.

Prof. E. L. Greene. 48 species of new or little known California plants, mostly from the islands of Santa Cruz and San Miguel.

Dr. Geo. Vasey. 23 species plants, mostly cultivated from seed in the Agricultural Grounds at Washington; remarkable fasciation of a flowering raceme *Sophora secundiflora*, from Texas.

Dr. A. Gattinger. 12 species of Tennessee plants.

Rev. Thomas Morong, through Isaac C. Martindale. 17 species of *Potamogeton*, being authenically named duplicates from the collection of Dr. J. W. Robbins.

Isaac C. Martindale. *Cyperus longus*, collected by Rugel at Austin, Texas.

Prof. F. L. Harvey. *Calla palustris*, from Orono, Maine.

Rev. Mr. Butler, through Thomas Meehan. 20 species plants from Labrador.

Aubrey H. Smith. 27 species plants collected by him near Warm Springs, N. C.

Richard H. Day. *Actinella acaulis* and *Clematis alpina*, from Colorado.

Dr. J. W. Eckfeldt. 30 species of N. American Lichens, of which 16 are new to the collection; 34 species of Hungarian Lichens, all new to the collection.

Dr. J. Bernard Brinton. *Rhus semialata*, var. *Osbeckii*, cultivated, a native of China and Japan.

W. A. Stowell. *Woodsia obtusa* and var. *Darlingtonii* of the same, N. Jersey.

G. W. Tryon, Jr. *Mikania scandens*, from Montgomery Co., Pa.

Thomas Meehan. 8 species plants collected by Mrs. Meehan in Florida and Louisiana, inFebruary 1887; *Phoradendron juniperinum* with berries, parasitic on *Juniperus occidentalis*, collected in Arizona by Dr. Robert Douglass; 55 species cultivated plants, mostly new to the collection; 449 species plants collected in South America (mostly in Bolivia), by H. H. Rusby in 1885 and 1886, of which 187 species new to the Herbarium; series of *Cinchona* plants from Bolivia, South America, consisting of 8 species and 7 varieties or hybrids, collected by H. H. Rusby.

John H. Redfield. 361 species of North American plants from his collection, most of them supplying gaps in the Academy's Herbarium; 131 species collec-

ted by C. G. Pringle in Chihuahua, Mexico, in 1886, of which 34 new to the Herbarium; 510 species collected by Dr. E. Palmer in Jalisco, Mexico in 1886, of which 259 are new to the collection.

PLANTS (Fossil).

G. W. Holstein. *Gyroiithes Holsteini* (alga) from the Carboniferous of Texas.
Mrs. W. Lorenz. Coal plants from Pennsylvania and Illinois, from the collection of the late Mr. W. Lorenz.

MINERALS AND ROCKS.

Isaac Burk. Sand concretion, from Woodbury N. J.
A. H. Smith. Fissure products from the Carolina earthquake.
Adele M. Fielde. Rock specimens from the Province of Quantung, China.
R. C. McMurtrie. Garnets, from Cuba.
Mrs. W. Lorenz. Collection of minerals, largely from Chester Co., Pa., collected by the late Mr. W. Lorenz.
J. Siemadzko. In exchange for a fragment of the Tennessee (Lea) meteorite:—Topaz, from Nertchinsk, Siberia; Topaz, from the Urals; Alexandrite, from Ekaterinenburg, Siberia; Beryl, from Nertschinsk.
W. E. D. Scott. Sand discharged by Carolina earthquake.
M. Deshong. Zoisite and Grossularite, from Leiperville, Pa.
Joseph Willcox. Coral-sand rock, Key West, Florida.
J. E. Ives. Nodule of Chlorite, from Lafayette, Pa.
T. A. Robinson. Fossiliferous rock and Pyrites, from Lake Temquisatto, Can.
S. R. Roberts. Hematite, from the Orinoco River, S. A.
H. W. Johns. Asbestos cloth.
T. D. Rand. Modified Quartz, from Falls of Schuylkill, Pa.
J. C. McNelly. Hematite, from mines in Blair Co., Pa.
H Ready. Nodule in carboniferous shale, Clearfield Co., Pa.
W. W. Jefferis. Muscovite, from Delaware Co., Pa.
Mineralogical and Geological Section A. N. S. Smoky quartz (part of crystal), from Macon Co., N. C.

ADDITIONS TO THE LIBRARY.

1887.

Abbott, Helen, C. De S. Plant chemistry as illustrated in the production of sugar from Sorghum. 8vo T. Philadelphia, 1887.
Plant analysis as an applied science. Philadelphia, 1887. 8vo T. The Author.
Alabama, Geological Survey of. Bulletin I, 1 and 2, 1886. Otto Meyer.
Albrecht, Paul. Ueber die cetoide Natur der Promammalia. Aug. 1886. 8vo T.
59 Versaml. deutscher Naturf. u. Aerzte zu Berlin. Aus der Sektion für Anatomie. Mittheilungen, Dez. 1886. 8vo T.
Verlaüft der Nervenstrom in nicht geschlossener, oder geschlossener Strombahn, und wie gelangt er wenn letzteres der Fall ist, zum Sitze der elektromotorischen Kraft zurück? Feb. 1887. 8vo T. The Author.
Vergleichend anatomische Untersuchungen. I, 2. I. V. Williamson Fund.
Allgemeine Naturkunde. Lief. 55–98. Leipzig 1886–87. I. V. Williamson Fund.
Andrejeff, K. Expedition der K. R. geogr. Gesell. Beobachtungen der russischen Polarstation auf Nowaja Semlja, II Th. Meteorologische Beobachtungen. 4to, 1886. The Society.
Arthur, J. C. History and biology of pear blight. June 1886. 8vo T. The Author.
Australian Museum, New South Wales. Report of the Trustees, 1886. The Trustees.
Baillon, M. H. Dictionnaire de botanique. 21me Fasc. I. V. Williamson Fund.
Baker, Walter & Co. Cocoa and chocolate. 8vo. Dorchester. 1780–1886. The Publishers.
Baldwin, D. D. Land shells of the Hawaiian Islands. 8vo T. The Author.
Barrois, Th. Role des insectes dans la fécondation des vegetaux. Thèse. 8vo. Paris, 1886. I. V. Williamson Fund.
Beaver, James A., Address of, Jan. 18, 1887. 8vo T. The Author.
Beddome, R. H. The ferns of British India. 2vol's. 4to. Madras 1866–1868.
The ferns of Southern India. 4to. Madras, 1873. John H. Redfield.
Beecher, Chas. E. A spiral bivalve shell from the Weaverly Group of Pennsylvania. 8vo T. Albany 1886. The Author.
Bellardi, Luigi. I molluschi dei terreni terziari del Piemonte e della Liguria. V, 1, 2. I. V. Williamson Fund.
Berghaus' physikalischer Atlas. 5e,–13e Lief. 1886–87. I. V. Williamson Fund.
Berlese, Aug. N. Fungi Moricolæ, IV. I. V. Williamson Fund.
Berthold, G. Studien über Protoplasma Mechanik 8vo. Leipzig, 1886. I. V. Williamson Fund.
Bibliographie des sciences medicales. 8vo. Paris, n. d. Messrs P. Blakiston, Son & Co.
Bibliotheca Americana. Suppl. 2. 8vo T. Paris, 1887. The Publisher.
Bigelow, Robert Payne. Contributions from the Cryptogamic Laboratory of the Museum of Harvard College. VII. 8vo T. Sept. 1887. The Author.
Bleeker, P. Ichthyologiæ Archipelagi Indici Prodromus. I. Siluri. 1858. I. V. Williamson Fund.
Board of Technical Education of New South Wales, report for 1885. 8vo. Sydney, 1886. The Board.
Bohemia. Naturwissenschaftliche Landesdurchforschung von Böhmen. VI, 3. I. V. Williamson Fund.

Bohnenseig, G. C. W. Repertorium annuum Literaturae Botanicae periodicae, VIII, 2. I. V. Williamson Fund.

Bolau, H. Der Elephant in Krieg und Frieden und seine Verwendung in unsern afrikanischen Kolonien. 8vo, T. Hamburg, 1887. Zoological Society of Hamburg.

Bolton, James. Filices Britannicæ. 4to. Leeds, 1785. John H. Redfield.

Bombicci, L. Sulla ipotesi dell' azione e selezione magnetica nel globo terrestre sulle materie cosmiche interplanetarie contenenti ferro. 4to T. 1887.

Sulla costituzione fisica del globo terrestre, sull'origine della sua crosta litoide. Sulle cause dei moti sismici che piu frequentemente vi Avengono. 4to T. 1887. The Author.

Borre, A. Preudhomme de. Catalogue des Trogides descrits jusqu'a ce jour. Mai. 1886. 8vo T.

Crustacés isopodes recueillis par feu Camille Van Volxem, pendant son voyage en Portugal en 1871. 8vo T.

Note sur le genre Ectinohoplia Redtenbacher. 8vo T.

Note sur les Triodonta aquila Cast. et Cribellata Fairm. 8vo T.

Liste des Lamellicornes laparostictiques recueillis par feu Camille Van Volxem pendant son voyage dans le Midi de la Peninsule Hispanique et au Maroc en 1871. 8vo T.

Notice sur les genres Hapalonychus Westwood et Trichops Mannerh. (inedit). 8vo T.

Anomale observée chez un Leucopholis rorida. 8vo T.

Sur les espèces Européennes du genre Haplidia. 8vo T.

Discours du Président de la Soc. Ent. de Belgique. 26 Dec. 1886. 8vo T.

Listes des especes de Coléoptères carnassiers terrestres et aquatiques authentiques capturées en Belgique. 1885. 8vo T.

Note sur les Crustacées isopodes de la Belgique. 8vo T. 1886.

Discours prononcé a l'Assemble générale du 20 Dec. 1885, de la Société Entomologique de Belgique. 1885. 8vo T.

Description de deux espèces nouvelles du genre Aegidium Westwood suivies de la liste des Orphnides du Musée royale d' Histoire Naturelle de Belgique. 8vo T. 1886. The Author.

Boulenger, G. A. Catalogue of the lizards in the British Museum, 2nd Ed. Vol. III. 8vo. London, 1887. The Trustees.

Bourguignat, M. J. R. Étude sur les noms génériques des petites paludinidées a opercule spirescent suivie de la description du nouveau genre Horatio. 8vo. Paris, 1887. The Author.

Boury, E. De Monographie des Scalidae vivants et fossiles. Pt. 1, Fasc. 1. 4to, Paris 1886. I. V. Williamson Fund.

Brauns, David. Einleitung in das Studium der Geologie. 8vo. Stuttgart, 1887. I. V. Williamson Fund.

Brinton, Daniel G. The conception of Love in some American languages. 8vo T. Philadelphia, 1886.

Were the Toltecs an historic nationality? Sept. 2, 1887. 8vo T.

A review of the data for the study of the prehistoric chronology of America. 8vo T. Salem, 1887.

Critical remarks on the editions of Diego de Landa's writings. 8vo T.

The phonetic element in the graphic system of the Mayas and Mexicans. 8vo T. The Author.

Britton, N. L. Contributions from the herbarium of Columbia College, No. I. Preliminary list of North American species of Cyperus, with descriptions of new forms. 1886. 8vo T. The Author.

Brown, Thomas. Colonial Museum and Geological Survey Department. Manual of the New Zealand Coleoptera. I and II. 8vo. New Zealand, 1880-81. The Survey.

Bronn's Klassen und Ordnungen des Thier-Reichs. 29 L. 4er Bd. 1-4 L. 6er, Bd., III Abth. 54-56 L., IV Abth. 16, 17, L., V, Abth. Wilson Fund.

Brot, A. Note sur quelques espèces de Melanies nouvelles ou imparfaitement connues. 8vo T. 1886. The Author.
Brühl, Carl Bernhard. Zootomie aller Thierklassen. Atlas, L. 34–39. 4to, Wien, 1886. I. V. Williamson Fund.
Buch, L. von. Palaeontologie (Bibliography.) 8vo T. The Author.
Buckler Wm. The larvæ of the British butterflies and moths. Vol. II. 1887. (Ray Society.) Wilson Fund.
Bucquoy, E., Ph. Dautzenberg and G. Dollfuss. Les mollusques marins de Roussillon. Fasc. 13. I. V. Williamson Fund.
Budai, Josef. Die secundaren Eruptivgesteine des Persanyer Gebirges. 8vo T. Budapest, 1886. Royal Hungarian Society of Natural History.
Buffalo Library. 51st annual report, 1887. The Trustees.
California State Mining Bureau. Annual report of the State Mineralogist. Parts I and II, for the year ending June 1, 1886. 8vo. Sacramento, 1887. The Bureau.
Canada. Geological and Natural History Survey. Annual report (new series), Vol. I, 1885. 8vo. Montreal, 1886. With portfolio of six folded maps. Sections for Report G. G. The Survey.
Meteorological Service of the Dominion of Canada, report of, 1884. By Charles Carpmael. The Author.
Carnelley, Thos., J. S. Haldane and A. M. Anderson. The carbonic acid, organic matter and micro-organisms in air. 4to T. London, 1887. The Author.
Carpenter, G. W. Essays on some of the most important articles of the Materia Medica. 2nd Ed. 8vo. Philadelphia, 1834. Messrs Geo. W. Carpenter & Co.,
Carpenter, P. Herbert. Note on the structure of Crotalocrinus. Nov. 1886. 8vo T. The Author.
Caruel, Teodoro. Parlatore's Flora Italiana, VI, 1, 2, 3,; VII, 1. The Editor.
La morphologia vegetale. 12mo. Pisa, 1878.
Prodromo della Flora Toscana. 8vo. Firenze, 1860–64.
Statistica botanica della Toscana ossia saggio di studi sulla distribuzione geografica delle piante Toscane. 8vo. Firenze, 1871.
Pensieri sulla tassinomia botanica. 8vo T. Roma, 1881.
La questione dei Tulipani di Firenze. 8vo T.
Note sur quelques points de la structure florale des Aracées. 8vo T. 1880.
Della conservazione degli erbari. 8vo T. 1887.
Classification des fruits. 8vo T. 1886.
Lettre a M. Malinvaud. 8vo T. 1886.
De la variabilité dans les plantes. 8vo T.
Illustratio in hortum siccum Andreæ Cæsalpini. 12mo T. 1858.
Pensées sur la taxinomie botanique. 8vo T. 1887. The Author.
Casey, Thos. L. Descriptive notices of North American coleoptera, I. Nov. 27, 1886. 8vo T.
On some new North American Pselaphidæ. July 18, 1887. 8vo T. The Author.
Challenger, report of the scientific results of the exploring voyage of. Botany II, Zoology, XVII; XVIII, 1, 2 and Plates; XIX. H. B. M. Government.
Chapman, Henry C. Treatise on human physiology. 8vo. Philadelphia. 1887. The Author.
Charleston, views in prominent places in. 8vo T. 1886. W. E. D. Scott.
Churchill, Dr. J. F. First and second reports of Free Stœchiological Dispensary for consumption etc. 8vo T. London, 1886. The Author.
Chyzer, Dr. Kornél. Magyarország Gyógyhelyei és Asványvizei. 12mo T. 1885. Royal Hungarian Society of Natural History.
City Hospital, Boston. 23rd annual report of the Trustees. 1886. 8vo T. The Trustees.

Caludius, Matthias. Dissertatio de Lagenorhynchis. 8vo T. Kiliæ, 1853.
I. V. Williamson Fund.
Cohn, F. Beitrage zur Biologie der Pflanzen, IV, 3.; V, 1.
Kryptogamen-Flora von Schlesien. 3e L. I. V. Williamson Fund.
Cooke, M. C. Grevillea, a monthly record of cryptogamic botany and its literature. I—VIII. 8vo. 1872-1880.
Executors of Dr. Geo. Martin.
A plain and easy account of the British fungi. 12mo. London, 1866.
Executors of Dr. Geo. Martin.
Mycographia seu Icones Fungorum. Pt. 4. I. V. Williamson Fund.
Collins, Jones. Brachionopoder, Muslinger og Snegle fra Kara-Havet.. 8vo T. Kjobenhavn, 1886. The Author.
Collins, J. W. Gill-nets in the cod fishery etc. 8vo T. April, 1881.
U. S. Fish Commission.
Columbia College. School of Library Economy. Circular of Information, 1887-8.
Annual Register, 1886-7. Fourth annual report of Librarian. 8vo T.
The Author.
Conigrave, John Fairfax. South Australia: a sketch of its history and resources. 8vo. London, 1886. R. Schomburgk.
Cooper, J. G. West Coast Pulmonata, fossil and living. 8vo T. 1887.
The Author.
Cooper, William, Biographical sketch of. 8vo T. New York, 1887.
The Authors.
Cope, E. D. The phylogeny of the Camelidæ. July, 1886. 8vo T.
Schlosser on the phylogeny of the ungulate Mammals. Aug. 1886. 8vo T.
Schlosser on Creodonta and Phenacodus. 1886. 8vo T.
Systematic catalogue of species of vertebrata found in the beds of the Permian epoch in North America. May 7, 1886. 4to T.
On two new species of three-toed horses from the Upper Miocene, with notes on the fauna of the Ticholeptus Beds. Feb. 19, 1886. 8vo T.
The vertebrata of the Swift Current Creek region of the Cypress Hills. 1885. 8vo T. The Author.
The origin of the fittest. 8vo. New York, 1887.
I. V. Williamson Fnnd.
Coppi, Francesco. Paleontologia Modenese. 8vo T. Modena, 1881.
The Author.
Cotes, E. C. and C. Swinhoe. A catalogue of the moths of India. Pt. 1, Sphinges. 8vo T. Calcutta, 1887. The Author.
Cousin, Aug. Faune malacologique de la Republique de l'Equateur. 1887. 8vo T. The Author.
Cubas, Ant. G. The Republic of Mexico 1876. 8vo T. Mexico, 1876.
The Mexican Goverment.
Dames W. and E. Keyser. Palaeontologische Abhandlungen, III, 4, 5.
I. V. Williamson Fund.
Dana James D. Kilauea after the eruption of March, 1886. Volcanic Action. Feb. 1887. 8vo T.
A dissected volcanic mountain; some of its revelations. Oct. 1886. 8vo T.
Note on the views of Prof. Emmons on the Taconic System. May, 1887. 8vo T. The Author.
Dawson, Geo. M. Note on the occurrence of jade in British Columbia and its employment by the natives. 8vo T. April, 1887.
On certain borings in Manitoba and the Northwest Territory. 1886. 8vo T. Montreal. The Author.
Dawson, J. William. On the fossil plants of the Laramie formation of Canada. 4to T. 1886. The Author.
Deichmüller, Dr. J. V. Ueber Urnenfunde in Uebigau bei Dresden. 8vo T. 1884. The Author.
Dimmock, George. Belostomidæ and some other fish-destroying bugs. 8vo T. 1886. The Author.

Dobson, G. E. Description of a new species of Vesperugo from North America. 8vo T. 1886.
Description of a new species of Soricidae in the collection of the Genoa Civic Museum. April. 1887. 8vo T. The Author.
Dollfus, Gustave & Ph. Dautzenberg. Étude préliminaire des coquilles fossiles des Faluns de la Touraine. 8vo T. Paris, 1886. G. Dollfus.
Dolley, Charles S. The technology of bacteria investigation. 12mo. Boston, 1885. I. V. Williamson Fund.
Dubois, A. Compte Rendu des observations ornithologiques faites en Belgique pendant l'aanée 1885. 8vo T.
Description de deux nouvelles espèces d'oiseaux. 8vo T. Bruxelles, 1887. The Author.
Dudley, William R. The Cayuga flora, Part I. 8vo. Ithaca, N. Y. 1886. Chas. E. Smith.
Eigner, A. Expedition der K. R. geographischen Gesellschaft. Beobachtungen der russischen Polarstation an der Lenamündung. II Th. Meteorologische Beobachtungen, I Lief. 4to. The Society.
Elliott, Henry W. A report upon the condition of affairs in the Territory of Alaska. 8vo. Washington 1875. In Exchange.
Encyclopædia Britannica. 9th Ed. XXI, XXII. I. V. Williamson Fund.
Encyklopædie der Naturwissenschaften. 1e Abth. 49-53 L.; 2e Abth. 39-45 L. I. V. Williamson Fund.
Engler, A. & K. Prantl. Die natürlichen Pflanzen Familien nebst ihren Gattungen und wichtigen Arten insbesondere der Nutzpflanzen bearbeitet etc. L. 1-11. I. V. Williamson Fund.
Erichson, W. F. Naturgeschichte der Insecten Deutschland. I Abth., 3er Bd. 2e A., 2e L. I. V. Williamson Fund.
Ettinghausen, Constantin Ritter v. Die Blatt-Skelete der Dikotyledonen. Folio. Wien, 1861. K. K. geol. Reichs., Wein, in exchange.
Everhart, Edg. Infant food and infant feeding. May 17, 1887. 8vo T. The Author.
Exploration Internationale des Régions Polaires, 1882-83 et 1883-84. Expedition Polaire Finlandaise. 4to. Society of Sciences of Finland.
Fairchild, Herman Le Roy. History of the New York Academy of Sciences. May 10, 1886. 8vo. New York, 1887. J. H. Redfield.
Fischer, P. Manual de Conchyliologie. Fasc. XI and Expl. des Planches. The Author.
Fischer, P. & H. Crosse. Mis. Scient. au Mex., Rech. Zool., 7me. Partie. Études sur les mollusques terrestres. The Authors.
Fish and Game Commissioners of Massachusetts. Report for the year ending December 31, 1886. 8vo T. The Commissioners.
Flower, W. H. A general guide to the British Museum (Natural History.) 8vo T. London, 1887. The Trustees.
Fokker, A. P. Untersuchungen über Heterogenese, I and II. 8vo. Groningen, 1887. I. V. Williamson Fund.
Folin, Le Marq. de. Sous les Mers. 12mo. Paris, 1887. I. V. Williamson Fund.
Folin, L. de and L. Périer. Les Fonds de la Mer. Vol's. I, II, III, IV, 1-12. 8vo. Paris 1867-1886. I. V. Williamson Fuud.
Forel, Auguste. Diagnoses provisoires de quelques espéces nouvelles de formis de Madagascar, récoltées par M. Grandidier, 1er. Mai, 1886. 8vo T.
Indian ants of the Indian Museum, Calcutta, No. 2. 1886. 8vo T,
Experiences et remarques critiques sur les sensations des insectes. 2me Partie, 1887. 8vo T. The Author.
Frazer, Persifor. The address of Vice-President G. K. Gilbert before Section E., A. A. A. S., Columbia College, New York, August 10, 1887. The Author.
Fremont, John Charles. Geographical memoir upon Upper California. 8vo. Washington, 1848. In Exchange.

Friedland & Sohn's Bibliotheca historico-naturalis et mathematica. Lager-Catalogue. 8vo. Berlin, 1886. The Publishers.

Fries, Elias. Systema Mycologicum, I. II, III. 1821-29.
Epicrisis Systematis Mycologici. 12mo. Upsaliæ, 1836-1838. Executors of Dr. Geo. Martin.

Furtado, Arruda. Sur une nouvelle espèce de cephalopode appartenant au Genre Ommatostrephes. 4to T. Lisbonne, 1887. The Author.

Gattinger, Aug. The Tennessee flora, with special reference to the flora of Nashville. 8vo T. Nashville, 1887. The Author.

Gaudry, M. Albert. Le petit Ursus spelæus de Gargas. 14 Mars, 1887. 4to T.
La grotte de Montgaudier. 8vo T. 22 Nov. 1886. The Author.

Gavoy, E. L'Encéphale, structure et description iconographique du cerveau, du cervelet et du bulbe. Texte and Atlas. 4to. Paris, 1886. I. V. Williamson Fund.

Gegenbaur, Carl. Zur Kenntniss der Mammarorgane der Monotremen. 4to T. Leipzig, 1886. I. V. Williamson Fund.

Genth, F. A. Contr. from the Chem. Lab. Univ. Penna. No. XXIX, Contributions to Mineralogy. 8vo T. March 18, 1887. The Author.

Geyler, H. Th. Zum Andenken an Herrn Adolf Metzler. 8vo T.
Verzeichniss der Tertiarflora von Flörsheim a/M. 8vo T.
Ueber eine japanische Tertiarflora. 8vo T.
Notiz über eine neuerdings aufgeschlossene Pliocänflora in der Umgebung von Frankfurt a/M. 1886. 8vo T.
Palæontologie. Bibl. Bot. Jahresb. 1884. 8vo T.
Ueber fossile Planzen von Labuan. 1887. 8vo T.

Geyler, H. Th. & Ph. F. Kinkelin. Oberpliocän-Flora aus den Baugruben des Klärbeckens bei Niederrad und der Schleuse bei Hochst a/M. 1887. 4to T. The Author.

Giles, Pearce. The true source of the Mississippi. 8vo T. The Author.

Girard, Maurice. Les Abeilles. 12mo. Paris, 1887. I. V. Williamson Fund.

Glaser, L. Catalogus etymologicus coleopterorum et lepidopterorum. 12mo. Berlin, 1887. I. V. Williamson Fund.

Godman, F. Ducane and Osbert Salvin. Biologia Centrali Americana. Zoology, Pt's 51-61. Botany, Pts 22 and 23. I. V. Williamson Fund.

Graff, Ludwig von. Die Fauna der Alpenseen. 8vo T. Graz, 1887. The Author.

Grandidier, Alfred. Histoire physique, naturelle et politique de Madagascar. Vol. 38. T. I, Atlas I, 1re partie. I. V. Williamson Fund.

Gray, Asa. Botanical contributions, March 4, 1887, I, II, and III. 8vo 7. The Author.

Greene, Edward Lee. Studies in the botany of California and parts adjacent, VI. 8vo T. 1887.
Pittonia. A series of botanical papers, I. 1. 1887. 8vo T. The Author.

Gregorio, Antonio de. Nota intorno ad alcuni fossili di Asiago. 8vo T. Pisa, 1886.
Nota intorno ad alcune conchiglie Mediterranée viventi e fossili. 8vo T. 1886.
Intorno a un deposito di roditori e di carnivori sulla vette di Monte Pellegrino. 8vo T. Pisa, 1886. The Author.

Gregory, Emily L. Comparative anatomy of the filz-like hair-covering of leaf-organs. Inaug. Dissert. 8vo T. Zurich, 1886. The Author.

Groth, P. Grundriss der Edelsteinkunde. 8vo. Leipzig, 1887. I. V. Williamson Fund.

Grove, J. H. Biography of Andrew Nebinger, M. D. May 11, 1887. 12mo T. Robert Nebinger.

Gümbel, Dr. K. Wilhelm von. Geologie von Bayern, 1er Th. Grundzüge der Geologie, 3e and 4e Lief. 8vo. 1886. I. V. Williamson Fund.

Günther, Alb. Guide to the galleries of reptiles and fishes in the Department of Zoology of the British Museum (Natural History). 8vo T. London, 1887. The Trustees.

Haas, Hippolyt J. Die Leitfossilien. 8vo. Leipzig, 1887. I. V. Williamson Fund.

Hanstein, Johannes v. Das Protoplasma als Träger der pflanzlichen und thierischen Lebensverrichtungen. 2e Ausg. 8vo. Heidelberg, 1887. I. V. Williamson Fund.

Hazslinszky, Frigyes. A Magyar Birodalom Moh-Flórája. 8vo. Budapest, 1885. Royal Hungarian Society of Natural History.

Hébert, Edm. Phyllades de Saint-Lô et conglomérat pourprés dans le nord-ouest de la France. 1887. 8vo T. The Author.

Hedwig, Joanne. Filicum genera et species recentiori methodo accommodatæ analytice descriptæ. Folio, Lipsiæ 1799. John H. Redfield.

Hegyfoky, Kabos. Die meteorologischen Verhaltnisse des Monats Mai in Ungarn. 4to T. Budapest, 1886. Royal Hungarian Society of Natural History.

Hehn, Victor. Kulturpflanzen und Hausthiere in ihrem Übergang aus Asien nach Griechenland und Italien sowie in das übrige Europe. 8vo. 5e, Aufl. Berlin, 1887. I. V. Williamson Fund.

Heilprin, Angelo. The geographical and geological distribution of animals. 8vo. New York, 1887.

Explorations on the west coast of Florida and in the Okeechobee Wilderness. 8vo. Philadelphia, 1886. The Author.

Heller, Agost. A. K. M. Termeszettudomanyi Társulat Könyveinek Czúnjegyzéke. II, Füzet. 8vo T. Budapest, 1886. Royal Hungarian Society of Natural History.

Helmholtz, H. von. Handbuch der physiologischen Optik. 2e, Aufl. L. 4. I. V. Williamson Fund.

Henry, Joseph, Scientific writings of. 2 vols. 8vo. Washington, 1886. Smithsonian Institution.

Herman, Otto. Ungarische Landesausstellung. Gruppe IV, Urgeschichte Spuren in den geräthen der ungarischen volksthümlichen Fischerei. 12mo T. Budapest, 1885. The Author.

Hertwig, Oscar and Richard. Untersuchungen zur Morphologie und Physiologie der Zelle. Heft 5. I. V. Williamson Fund.

Heude, P. Problema Philippinense. Fol T. Zi-ka-Wei, 1887. The Author through Dr. Leidy.

Hicks, Henry. Further proofs of the Pre-Cambrian age of certain granitoid, felsitic and other rocks in N. W. Pembrokeshire. 8vo T. Aug. 1886. The Author.

Higgins, James. Second, third and fourth reports to the House of Delegates of Maryland. 8vo. Annapolis and Baltimore, 1852–54. In Exchange.

Hinde, George Jennings. On the Genus Hindia, Duncan, and the name of its typical species. 8vo T. Jan. 1887.

On the organic origin of chert in the carboniferous limestone series of Ireland. Oct. 1887. 8vo T. The Author.

Hitchcock, C. H. Geological map of the United States, 1886. The Author.

Hoffman. Hermann. Icones analyticæ fungorum, H. 2 and 3. I. V. Williamson Fund.

Hooker, Jos. D., Framed photograph of. John H. Redfield.

Hooker, William Jackson. A century of ferns. 2 vols. 8vo. London, 1854–1861.

Genera filicum. 8vo. London, 1842.

Filices exoticæ. 4to. London, 1859. John H. Redfield.

Horne, A. R. Easy experiments for schools and families with homemade apparatus. 12mo T. Chicago, 1886. The Author.

Hornizky, K. S. Record of the Russian and of some foreign names of plants. Kharkow, 1886. 8vo T.

Notes on the use in popular life of some wild-growing and cultivated plants of the Ukrianic (Southern Russian) Flora. Kharkow, 1887. 8vo T. The Author.

Hovelacque, Abel and Georges Hervé. Bibl. Anth. Précis d'anthropologie. 8vo. Paris, 1887. I. V. Williamson Fund.

Hubbard, Lucius L. Beitrage zur Kenntniss der Noseanführenden Auswürflinge des Laacher Sees. Inaug. Dissert. 8vo T. Wein, 1887. The Author.

Hudson, C T. and P. H. Gosse. The Rotifera; or wheel animalcules, Pt. VI. 1886. I. V. Williamsou Fund.

Hutton, F. W. On the geology of the Trelissick or Broken River Basin, Selwyn County. June 3, 1886. 8vo T.

The eruption of Mount Tarawera. May, 1887. 8vo T.

Report on the Tarawera Volcanic District. 8vo T. The Author.

India, Geological Survey of. Memoirs, 4to. Palæontologia Indica. Ser. VII and XIV, Vol. I, Title; Ser. X, Vol. IV, Pt. 2. Ser. XII, Vol. IV, Pt. 2; Ser. XIII, 1, 6. Records, XIX, 4; XX, 1 and 2. The Survey.

Inkey, Béla von. Magyag und seine Erzlagerstätten im Auftrage der K. U. naturwissenschaftlichen Gesellschaft. 4to T. Budapest, 1885. Royal Hungarian Society of Natural Science.

Internationale Polarforschung, 1882, 1883. Die österreichische Polarstation Jan Mayen ausgerüstet durch S. E. Graf Hannas Wilczek geleitet vom H. K. Corvetten-Capitän Emil Edlen von Wohlgemuth. I; II, 1, 2; III. 4to. Wien. I. V. Williamson Fund.

James, U. P. and J. F. James. On the monticuliporoid corals of the Cincinnati Group. July 5, 1887. 8vo T. The Authors.

Janke, Heinreich Die willkurliche Hervorbringung des Geschlechts bei Mensch und Hausthieren. 8vo. Berlin, 1887. I. V. Williamson Fund.

Jenkins, O. P. List of fishes collected in Vigo County in 1885 and 1886. 8vo T. The Author.

Jousseaume, F. Mollusques nouveaux. 1887. 8vo T.

Mollusques nouveaux de la Republique de l'Equateur. 1887. The Author.

Just's Botanischer Jahresbericht, XI, 2e Abth. 2 H.; XII. 1e Abth. 1 H., 2e Abth. 1 H. I. V. Williamson Fund.

Kaulfuss, Georg. Frid. Enumeratio filicum quas in itinere circa terram legit Cl. Adalbertus de Chamisso adjectis in omnia harum plantarum genera permultasque species non satis cognitas vel novas animadversionibus. 12me, Lipsiæ, 1824. John H. Redfield.

Keep, Josiah. West coast shells. 12me. San Francisco, 1887. I. V. Williamson Fund.

Kentucky, Geological Survey of; John R. Procter, Director. Report on the geology of Elliott County. By A. R. Crandall. Also notes on the trap dikes of Elliott County. By A. R. Crandall and J. S. Diller. 8vo T. 1886.

Shaler's report of progress. III, 1887. Six preliminary maps. 1886, 1887. The Survey.

Kerz, Ferdinand. Ueber die Entstehung der Körper welche sich um die Sonne bewegen. 8vo T. Leipzig, 1886. I. V. Williamson Fund.

Killebrew, J. B. First and second reports of the Bureau of Agriculture for the State of Tennessee. Introduction to the resources of Tennessee. 8vo. Nashville, 1874. In exchange.

Kirchoff. Unser Wissen von der Erde. 2er Bd., I Th. 1 and 2. I. V. Williamson Fund.

Knauer, Friedrich. Handwörterbuch der Zoologie. 8vo. Stuttgart, 1887. I. V. Williamson Fund.

Kobelt, W. Das Verhältniss der europäischen Land-molluskenfauna zur Westindisch Centralamerikanischen. 1887. 8vo T.

Suezcanal und Mittelmeerfauna. 1887. 8vo T. The Author.

Prodromus Faunæ Molluscorum Testaceorum maria europaea inhabitantium. Fasc. 1-3. 8vo. Nürnberg, 1886.

Iconographie der schalentragenden europäischen Meeresconchylien, H. 4–7. Cassel, 1883. I. V. Williamson Fund.
Die geographische Verbreitung der Heliceengruppe Macularia. 8vo T. The Author.
Koch, Ludwig. Die Entwicklungsgeschichte der Orobranchen. 8vo. Heidelberg, 1887. I. V. Williamson Fund.
Kokscharow, N. v. Materialen zur Mineralogie Russlands. IX, 18, 23. I. V. Williamson Fund.
Kunze, Gustav. Die Farrnkräuter in kolorirten Abbildungen naturgetreu erläutert und beschrieben. 2 vols. in one, 4to. Leipzig, 1840–47.
Analecta Pteridographica. Fol. Lipsiæ 1837. John H. Redfield.
Kunze, Gustav and Johann Carl Schmidt. Mykologische Heft, 2es. Heft. 8vo. Leipzig, 1823. Executors of Dr. Geo. Martin.
Lacordaire, M. Th. Histoire naturelle des insectes. Genera des coléoptères. T. 8me. Tricténotomides et Longicornes. 8vo. Paris, 1869. American Entomological Society.
László Eduard D. Chemische und mechanische Analyse ungarländischer Thone mit Rücksicht auf ihre industrielle Verwendbarkeit. 8vo T. Budapest, 1886. Royal Hungarian Society of Natural Science.
Lawes, Sir John Bennett. Memoranda of the origin etc. of experiments at Rothamsted. June, 1887. Fol T. The Author.
Lawrence, Geo. N. The rediscovery of Bachman's warbler, Helminthophila Bachmani Aud. in the United States. Jan. 1887. 8vo T.
Descriptions of new species of birds of the families Sylviidæ, Troglodytidæ und Tyrannidæ. May 9, 1887. 8vo T.
Description of a new species of thrush from the Island of Grenada, West Indies. Feb. 28, 1887. 8vo T. The Author.
Lea, M. Carey. Papers on the photochemistryof the silver haloids. June and July 1887. 8vo T. The Author.
Lee, Arthur Bolles. The microtomist's vade-mecum. 8vo. London, 1885. I. V. Williamson Fund.
Lesley, J. P. Second Geological Survey of Pennsylvania. Letter to the Governor, Dec. 31, 1874. 8vo T. In exchange.
Lepsius, R. Handb. z. deutschen Landes und Vols. Geologie von Deutschland und den angrenzenden Gebieten. I, 1. I. V. Williamson Fund.
Letourneux, A. and J. B. Bourguignat. Expl. Scient. de la Tunisie. Prodrome de la malacologie terrestre et fluviatile de la Tunisie. Paris, 1887. 8vo T. The Authors.
Leuckart, Rudof. Die Parasiten des Menschen und die von ihnen herrührenden Krankhelten. I, 3. 2e. Aufl. 8vo. Leipzig u. Heidelberg, 1886.
i I. V. Williamson Fund.
Lewis, H. Carvill. The matrix of the diamond. Sept. 7, 1887. 8vo T.
On some important extra-marine lakes in Central England, North America and elsewhere. Sept. 2, 1887. 8vo T.
The terminal moraines of the great glaciers of England. Sept. 2, 1887. 8vo T.
On a diamantiferous peridotite, and the genesis of the diamond. Comparative studies upon the glaciation of North America, Great Britain and Ireland. 8vo T. 1887.
The alleged physical phenomena of spiritualism. 8vo T. The Author.
Lewis, T. H. Snake and snake-like mounds in Minnesota, 1887. 8vo T.
Incised boulders in the Upper Minnesota Valley. 8vo T. 1887. The Author.
Light House Board, annual report, June 30, 1886. 8vo. Washington, 1886. Treasury Department.
Linden, J. Lindenia. Iconographie des orchidées. I, II. Gand, 1885, 87. [illegible]
Lockwood, Samuel. Raising diatoms in the laboratory. 8vo T. New York, 1886. The Author.

Lombard, J. S. Experimental researches on the regional temperature of the head under conditions of rest, intellectual activity and emotion. 8vo. London, 1879.

Experimental researches on the temperature of the head. 8vo. London, 1881. The Author.

Lowe, E. J. Ferns: British and exotic. Eight volumes. 8vo. London, 1856–1864.

A Natural History of new and rare ferns. 8vo. London, 1864. John H. Redfield.

Lischke, C. E. Japanische Meeres-Conchylien 3er Th. 4to, Cassel, 1874. I. V. Williamson Fund.

Ludwig Ferdinand, K. Prinz von Bayern. Zur Anatomie der Zunge. 4to, Müchen 1884. I. V. Williamson Fund,

Lydekker, Richard. Catalogue of the remains of Siwalik vertebrata contained in the Geological Department of the Indian Museum, Calcutta. Part I, mammalia; Part II, aves, reptilia and pisces. 8vo. Calcutta 1885–86.

Catalogue of the remains of pleistocene and prehistoric vertebrata contained in the Geological Department of the Indian Museum, Calcutta. 8vo T. 1886. The Author.

Catalogue of the fossil mammalia in the British Museum (Natural History). Part IV. 8vo. London, 1886. The Trustees.

McCook, Henry C. Modifications of habits in ants through fear of enemies. 8vo T. 1887. The Author.

McCreath, Andrew S. and E. V. d'Invilliers. The new River-Cripple Creek mineral region of Virginia. 8vo. Harrisburg, 1887. E. V. d'Invilliers.

McLoughlin, J. W., M. D. Researches into the etiology of the dengue. 8vo T. Chicago, 1886. The Author.

Maine Board of Agriculture. Sixth and seventh annual report of the Secretary. 1861 and 1862. 8vo. Augusta, 1861–62. In exchange.

Maisch, J. M. Gotthief Heinrich Ernst Muhlenberg als Botaniker. 8vo T. 1886. The Author.

Man, J. G. De. Anatomische Untersuchungen über freilebende Nordsee-Nematoden. Fol. Leipzig, 1886. I. V. Williamson Fund.

Marsh, Othniel Charles. Dinocerata, a monograph of an extinct order of gigantic mammals. (Monogr. U. S. Geol. Surv. Vol. X.) 4to. Washington, 1886. Department of the Interior.

American Jurassic mammals. April, 1887. 8vo T. The Author.

Martin George. Archetypa fungorum manu propria pinxit Georgius Martin M.D. 1882–'83, 1883–'86. 2 vols. 4to. Executors of Dr. Geo. Martin.

Martini & Chemnitz. Systematisches Conchylien Cabinet. L. 341–352. Wilson Fund.

Martius, C. F. P. de, & A. G. Eichler. Flora Brasiliensis enumeratio plantarum in Brasilia hactenus detectarum. Fasc. 1, 6, 12, 15–24, 27–96. Fol. 1840 Mar. 1886. The Department of Agriculture, Commerce and Public Works, Brazil.

Maverick National Bank manual. July 1, 1887. 12mo. Boston, 1887. The Directors.

Medley, Geo. W. Fair trade unmasked. 12mo T. Cobden Club.

Meinert, Fr. Entomologiske Medelelser, I, 1. 1887. I. V. Williamson Fund.

Menke, Carolo Theod. Synopsis methodica molluscorum, etc. Editio altera. 8vo. Pyrmonti, 1830. I. V. Williamson Fund.

Merriam, C. H. The mammals of the Adirondack Region. 8vo. New York, 1886. I. V. Williamson Fund.

Mettenius, Georg. Filices Horti Botanici Lipsiensis. Fol. Leipzig, 1856. John H. Redfield.

Meusel, Eduard. Die Quellkraft der Rhodanate und die Quellung als Ursache fermentartiger Reaktionen. 8vo T. Gera, 1886.
I. V. Williamson Fund.

Mexican Border Commission. Reports of the Committee of Investigation sent in 1873 by the Mexican government to the frontier of Texas. 8vo. New York, 1875. The Mexican Goverment.

Meyer, Otto. Beitrag zur Kenntnis der Fauna des Alttertiärs von Mississippi und Alabama, 1887. 8vo T. The Author.

Microscopical Society of West Chester, Penna. Report on the Act of Assembly of said State awarding a premium for the destruction of hawks, owls, minks, weasels etc. enacted June 23, 1885. 8vo T. West Chester, 1887.
B. H. Warren.

Mihalkovics, Geza. A gerinczes állotok kiválasztó és ivarszerveinek fejlödése. 8vo. Budapest, 1885. Hungarian Academy of Science.

Ministry of Finance, France. Diamonds, pearls and precious stones taken from the collection known as the crown jewels. 4to T. 1887. Tiffany & Co.

Minnesota. The Geological and Natural History Survey of. 13th and 14th Annual Reports 1884, 1885. N. H. Winchell, State Geologist. 2vols. 8vo. St. Paul, 1885, 1886. The Survey.

Moder, Jos. Denkschrift über die zehntheilige Uhr für Jahr und Tag. 4to T. Wiesbaden, 1887. The Author.

Montague, F. C. Technical education. 12mo T. Cobden Club.

Monterosato. Marchese T. Allery di. Testacei nuovi dei Marie di Sicilia. 8voT. Palermo, 1869. I. V. Williamson Fund.

Moore, Thomas. Index Filicum. 12mo. London, 1857. John H. Redfield.

Mueller, Ferd. von. Descriptions and illustrations of the myoporinous plants of Australia. II, Lithograms. 4to. Melbourne, 1886. Thomas Meehan.

Museum d'Histoire Naturelle des Pays-Bas, IX. I. V. Williamson Fund.

Muspratt, Sheridan. Chemistry, theoretical, practical aud analytical as applied and relating to the arts and manufactures. Vol. 1 and Vol. 2 as far as part 52. Dr. W. S. W. Ruschenberger.

Muybridge, Eadweard. Animal locomotion. An electrophotographic investigation of consecutive phases of animal movements. 1872–1885. Set of one hundred and three plates. Folio. 1887. I. V. Williamson Fund.

Animal Locomotion. Prospectus and catalogue of plates. 12mo T. Philadelphia, 1887. The Author.

Nabias, B. Les Galles et leur habitants. Thèse. 8vo. Paris, 1886.
I. V. Williamson Fund.

Naglei, C. v. and A. Peter. Die Hieracien Mittel-Europas. II Bd. 2 H. 8vo. München, 1886. I. V. Williamson Fund.

Newberry, J. S. Food and fibre plants of the North American Indians. 8vo T. New York, 1887. The Author.

The ancient civilizations of America; their origin and antiquity. 8vo T. New York, 1885. The Author.

New Jersey. Geological Survey of. Atlas, sheets 5, 8, 10, 11, 12. 14, 15.
Geo. H. Cook.

New York Free Circulating Library. 7th annual report, 1886. 8vo T.
The Author.

New Zealand. New Zealand Industrial Exhibition 1885. Wellington. The Official Record. 8vo. 1886. The Director.

Noll, Henry R. The botanical class-book and flora of Pennsylvania. 12mo. Lewisburg, 1852. Isaac Burk.

Northrop, J. I. Contributions from the herbarium of Columbia College, No. 3. Plant notes from Termiscouata County, Canada. 8vo T. No 1887.
The Author.

Norway. Norwegische Commission der europæischen Gradmessung. Geodätische Arbeiten, H. V. Vandstandsobservationer II. IV. The Commission.

Norwegian North-Atlantic Expedition, 1876—1878. XV-XVIII, Zoology.
The Norwegian Government.

Nova Scotia. Report of the Department of Mines for the year 1886. 8vo. Halifax, 1887. The Director.

Nuttall, Thos., Framed photograph of. John H. Redfield.

Nuttall, Zelia. Preliminary note of an analysis of the Mexican codices and graven inscriptions. Aug. 1886. 8vo T. The Author.

Nyman, C. F. Sylloge floræ Europææ. 8vo. Oerebroæ, 1854–1855. John H. Redfield.

Ochsenius, Carl. Über das Alter einiger Theile der südamericanischen Anden. 8vo T. Marburg 1886. The Author.

Orgeas J. La pathologie des races humaines et le probleme de la colonisation. 8vo. Paris, 1886. I. V. Williamson Fund.

Osborn, Henry F. The Upper Triassic mammals, Dromatherium and Microconodon. April, 1887. 8vo T.

On the structure aud classification of the Mesozoic mammalia, June 21, 1887. 8vo T. The Author.

Owen, D. D. Report of a geological reconnoissance of the State of Indiana, 1837. Part First. 8vo. Indianapolis, 1859. In Exchange.

Packard, A. S. On the carboniferous xiphosurous fauna of North America. 4to T.

On the Anthracaridæ, a family of Carboniferous macrurous decapod crustacea. 4to T.

On the Gampsonychidæ. 4to T.

On the Syncarida. 4to T. The Author.

Paetel, Fr. Catalog der Conchylien Sammlung. 1e L. 8vo. Berlin, 1887. The Author.

Parlatore, Filippo. Flora Italiana, continuata da Teodoro Caruel. VI, 1, 2, 3; VII, 1.

Les collections botaniques du Musée Royale de physique et d'histoire naturelle de Florence au printemps de 1874. 8vo. Florence, 1874.

Viaggio per le parti settentrionale de Europa fatto nell' anno 1851. I. 8vo Firenze, 1854. T. Carue.

Palaeontographica. XXX, 4–6; XXXII, 5, 6; XXXIV, 1. Wilson Fund.

Paléontologic Francaise. 1re Ser. An. Inv. L. 10. Terrains Tertiaires, Eocene Echinides I, f. 16–23, p. 73–108. Terrain Juras. L. 82, 83, 84. Crinoides f. 10–12, p. 159–170. Ter. Crétaces, L. 23. Wilson Fund.

Peale, A. C. Department of the Interior. U. S. Geol. Surv. Mineral waters. 1885. 8vo T. Washington 1886. The Author.

Peale, A. C. Wm. H. Seaman M. D., and C. H. White M. D. Report of committee on methods of stating water-analyses. 8vo T. Washington, 1887. A. C. Peale.

Pennsylvania. Annual report of the Geological Survey for 1886. 8vo. Harrisburg, 1887. Charles M. Betts.

Report of the Secretary of Internal Affairs, containing reports of the surveys and re-surveys of the boundary lines of the Commonwealth. 2vols. text and maps. 8vo. Harrisburg 1887. Charles M. Betts.

State Board of Health and Vital Statistics. First annual report, Dec. 7, 1885. 8vo. Harrisburg, 1886. The Board.

Péres de la Compagnie de Jésus. Memoires concernant l'histoire naturelle de l'Empire Chinois. II. 1. I. V. Williamson Fund.

Pergens, Éd. et A. Meunier. La faune des Bryozoaires Garumniens de Faxe. Bruxelles, 1886. 8vo. T. The Author.

Pfitzer, E. Entwurf einer natürlichen Anordnung der Orchideen. 8vo T. Heidelberg, 1887. I. V. Williamson Fund.

Portugal. Commission des travaux géologiques du Portugal. Recueil d'études paléontologiques sur la faune crétacique du Portugal. I, pp. 1–40. II, 1er, Fasc. Geological Survey of Portugal.

Potts, Edw. Fresh-water sponges. A monograph. 8vo. Philadelphia, 1887. The Author.

Presl, Carolo Bor. Tentamen pteridographiæ. 8vo. Prague, 1836.
John H. Redfield.
Procter, John R. Kentucky Geological Survey. Preliminary maps, by J. B. Hoeing, 1886, 1887. Six maps. The Survey.
Putnam, F. W. Conventionalism in ancient American art. Salem 1887. 8vo T.
Serpent Mound Park, Cincinnati. 1887. (Slip.) The Author.
Quain, Jones. Elements of anatomy. 9th edition, 2 Vols. 8vo. London, 1882,
I. V. Williamson Fund.
Quatrefages, A. de. Les pygmées. 12mo, Paris, 1887. I. V. Williamson Fund.
Quenstedt, F. A. Die Ammoniten des schwäbischen Jura. Heft 13–16. Text and Atlas. I. V. Williamson Fund.
Rabenhorst, Dr. L. Beiträge zur näheren Kenntniss und Verbreitung der Algen. H. II. Leipzig, 1865.
Kryptogamen-Flora von Deutschland, Oesterreich und der Schweiz. I, 2e. Abth. 25, 26, 28 L and Register; III, 9 and 10 L.; IV, 5–7 L.
I. V. Williamson Fund.
Rath, G. vom. Einige geologische Wahrnehmungen in Mexiko. Okt. 1886. 8vo T. Bonn. 1887.
Einige geologische Wahrnehmungen in Griechenland, 1887. 8vo T.
Als Willkommgruss zur Versammlung der deutschen geologischen Gesellschaft in Bonn. Einige mineralogische und geologische Mittheilungen. 8vo T.
Worte der Erinnerung an Dr. Martin Websky, 1886. 8vo T.
Friedrich Pfaff, 1887. 8vo T.
Uber künstliche Silberkrystalle, 8vo T. 1887, The Author.
Reichenbach, H. G. L. Flora Saxonica. Die Flora von Sachsen, ein botanisches Excursionsbuch. 8vo. Dresden und Leipzig, 1842. Thomas Meehan.
Renevier, E. Rapport sur la marche du Musée géologique Vaudois en 1886. Lausaune, Mai, 1887. 8vo T. The Author.
Retzius, Gustaf. Das Gehörorgan der Wirbelthiere, morphologisch-histologische Studien, I, II. 2 vols. fol. Stockholm, 1881–1884.
I. V. Williamson Fund.
Richon, C. and E. Roze. Atlas des champignons comestibles et vénéneux. Fasc. 2–7. Fol. Paris. I. V. Williamson Fund.
Ridgway, R. A nomenclature of color for naturalists and compendium of useful knowledge for ornithologists. 8vo. Boston, 1886.
A manual of North American birds. 8vo. Philada. 1887.
I. V. Williamson Fund.
Riley, C. V. U. S. Department of Agriculture, Division of Entomology, Bulletin, No. 10. Our shade trees and their insect defoliators. 8vo T. Washington, 1887. The Department.
Rodrigues, J. Barboza. O Tamakoare especies novas da ordem das Ternstroemiaceas 4to T. Manaos, 1887. The Author.
Rossmassler's Iconographie der europaischen land und susswasser-Mollusken (Kobelt). N. F. II, 5, 6; III, 1, 2. I. V. Williamson Fund.
Rothrock, J. T. Biographical memoir of the late Eli K. Price. Nov. 19, 1886. 8vo T. The Author.
Ruiz, H. and J. Pavon. Floræ Peruvianae et Chilensis prodromus. Fol. Madrid, 1794. Thomas Meehan.
Russia. Comité Geologique Russe. Bulletin, 1886, Nos. 7–11. 1887, Nos. 1–5. The Survey.
Ryder, John A. On the origin of heterocercy and the evolution of the fin and fin-rays of fishes. 8vo T. Washington, 1886.
Automatic microtome. Am. Nat. March 1887. 8vo T. The Author.
Saccardo, P. A. Fungi Italici autographice delineati. I, Tab. 1–1120; II, Tab. 1121–1500. 2 vols, 4to. Patavii 1877–1886.
Michelia, Commentarium mycologicum fungos in primis Italicos illustrans. I, II, Patavii 1879, 1882. Executors of Dr. Geo. Martin.
Sylloge fungorum. V. Agaricineae, Additamenta ad Vol. I–IV.
I. V. Williamson Fund.

Sandberger, F. v. Bemerkungen über einige Heliceen im Bernstein der preussischen Küste. 8vo T. Danzig. The Author.
Sanders, Christ. B. The physical nature of the earth and a new philosophy of light. 8vo T. Houston, 1887. The Author.
Sarasin, P. and F. Ergebnisse naturwissenschaftlicher Forschungen auf Ceylon in den Jahren, 1884–1886. I, 1; II, 1. Fol. Wiesbaden 1887. I. V. Williamson Fund.
Saussure, Henri de. Spicilegia entomologica Genavensis. 2. Tribu des Pamphagiens. 4to T. Geneve 1887. The Author, 1887.
Memoires pour servir a l'histoire naturelle du Mexique des Antilles et des États-Unis. 1re, 2e and 3e. Livr. V Memoire. T. 2, 1e Partie. I. V. Williamson Fund.
Mélanges orthopterologiques. 1er, 2 and 6me, Fasc. I. V. Williamson Fund.
Say, Thomas. Portrait in oil of, by C. W. Peale. Mrs. J. E. Mitchell.
Schidte, J. C. Zoologia Danica. 5 H. 1887. I. V. Williamson Fund.
Schkuhr, Christian. Vier und zwanzigste Klasse des linnéischen Pflanzensystems oder kryptogamische Gewächse. 4to, Wittenberg, 1809. Text and Plates. John H. Redfield.
Schlechtendal, D. F. L. de. Adumbratio filicum in Promontorio Bonae Spei provenientium (1825–1832). 4to. John H. Redfield.
Schomburgh, R. Report on the progress and condition of the Botanic Garden (South Australia) during the year 1886. Fol. T. The Author.
Schmidt, Adolf. Atlas der Diatomaceen-Kunde. H. 27, 28. I. V. Williamson Fund.
Schneider, Anton. Zoologische Beitrage. II, 1. I. V. Williamson Fund.
Schwalbe, G. Lehrbuch der Anatomie der Sinnesorgane. 8vo. Erlangen, 1887. I. V. Williamson Fund.
Schwedoff, Th. Les mouvements cycloniques. 8vo T. Paris, 1887. The Author.
Scribner, F. L. Dep. of Agric.. An. Report 1886. Report of the Mycologist. 8vo T. 1887. The Author.
Semper, C. Reisen im Archipel der Philippinen. Wissenschaftlichen Result. IV. 2; V, 1; 2er Th. 2er Bd. Suppl. H. IV, 2e II. I. V. Williamson Fund,
Seynes, J. de. Recherches pour servir a l'histoire naturelle des vegetaux inferieurs, III. 1886. I. V. Williamson Fund.
Shaler, N. S. Geological Survey of Kentucky. Report of Progress III, n. s. 1877. The Survey
Sibthorp, John. Flora Graeca; sive plantarum rariorum historia quas in Provinciis aut Insulis Græciæ legit. Ten volumes, folio. London, 1806–1840. By subscription.
Siemachko, Julien de, Catalogue de la collection de meteorites de. Jan. 1886. Paris. 8vo T. The Author.
Smith, Eugene Allen. Geological Survey of Alabama. On the Warrior Coal Field, by Henry McCalley, A. M. 8vo. Montgomery, Alabama. 1886. The State Geologist.
Solms-Laubach, H. Grafen zu. Einleitung in die Paläophytologie vom botanischen Standpunkt aus. 8vo. Leipzig, 1887. I. V. Williamson Fund.
South African Museum, Cape of Good Hope. Report of the Trustees. 1886. The Trustees.
Sowerby, G. B. Thesaurus Conchyliorum. XI, IV. Wilson Fund.
Stadler, S. Beiträge zur Kenntniss der Nectarien und Biologie der Blüthen. 8vo. Berlin, 1886. I. V. Williamson Fund.
Stephenson, F. B., M. D. A summary of Holsti's views of arterio-capillary Sclerosis. Nov. 20, 1886. 8vo, T. The Author.
Stevenson, John. Hymenomycetes Britannici. British fungi (Hymenomycetes). Vols. 1 and 2. 8vo. Edinburgh, 1887. I. V. Williamson Fund.
Stossich, M. I distomi dei pesci marini e d'acqua dolce. 1886. 8vo T. The Author.

Surgeon-General's Office, U. S. Army. Index-catalogue of the library, Vol. VIII. 1887. War Department.
Suringar. Musée botanique de Leide. I, 4 and 5; II pp. i-viii, 1-16, Pls 7-9. I. V. Williamson Fund.
Sutro, Theodore. The Sutro Tunnel Company. 12 mo. New York, 1887. The Author.
Swartz, Olai. Synopsis filicum. 12mo. Kiliae 1806. John H. Redfield.
Sydow, P. Die Flechten Deutschlands. 8vo. Berlin 1887. I. V. Williamson Fund.
Szabo, Jozsef. Geologia kivláó tekintettel a Petrografiára Vulkanossagra és hidrografiára. 8vo. Budapest, 1883. Angelo Heiprin.
Taschenberg, O. Bibliotheca zoologica. II, 1-3. I. V. Williamson Fund.
Taylor, Thos. Reply to "Science." Relating to the crystals of butter, animal fats and oleomargarine. Nov. 19, 1886. 8vo T. The Author.
Teall, J. J. Harris. British petrography, Parts 9 and 10. Birmingham. I. V. Williamson Fund.
Thaxter, Roland. On certain cultures of gymnosporangium, with notes on their roesteliæ. Dec. 8, 1886. 8vo T. The Author.
Thompson, Edw. H. Archæological researches in Yucatan. 8vo T. Worcester. 1886. The Author.
Thomson, Sir C. Wyville. Report of the scientific results of the voyage of H. M. S. Challenger during the years 1873-1876. Zoology XX; XXI, text and plates; XXII. H. B. M. Government.
Thore, J. 1re, 2me and 3me communication sur une nouelle force? Dax, 1887. 8vo T. The Author.
Torrey, John, Card portrait of. Through the Botanical Section.
Towne, Edward C. Electricity and life. Cambridge, 1887. 8vo T. The Author.
Trask, Dr. John B. Report on the geology of the Coast Mountains and part of the Sierra Nevada. 1854. 8vo. T. In Exchange.
Tryon, Geo. W. Jr. Manual of conchology, structural and systematic. Parts 33-35. Second series, Pulmonata, Parts 9-11. The Author.
Tuckerman, Frederick. The tongue and gustatory organs of Mephitis mephitica. 8vo T. Aug. 1887. The Author.
Tyson, Philip T. Geology and industrial resources of California. 8vo. Baltimore, 1851. In Exchange.
Uhlworm, Oscar and F. H. Haenlein. Bibliotheca botanica. H. 2-8. I. V. Williamson Fund.
United States Bureau of Ethnology. Annual report, 1882-83. The Director.
Commission of Fish and Fisheries. Parts XII and XIII. Reports for 1884 and 1885. The Commission.
Commissioner of Patents. Reports for the years 1849-50, 1850-51, 1851-52, 1852-53, 1859, 1861. Agriculture. 8vo. Washington 1850-1862. In Exchange.
Department of Agriculture. Reports of Commissioner, 1875 and 1876. 8vo. Washington, 1877. Botanical Division. Bulletin, Nos. 3 and 11. Division of Entomology, Bulletin, Nos. 10, 13-16 inclusive. Dr. C. V. Riley. The Department.
Department of the Interior. Census Office. Tenth census of the United States. Vol. XV, XVI, XVIII. 4to. Washington 1886. Department of the Interior.
Commissioner of Education. Report for the year 1884-1885. Circulars of information, 1886, No. 2. The Department.
Commissioner of Labor's second annual report, 1886. Convict labor. 8vo. Washington, 1887. The Department.
U. S. Geological Survey, Monograph. Vols. X and XI. Sixth annual report, 1884-85. Mineral resources of the United States, 1885. Bulletin Nos. 30-39 inc. The Department.

Department of State. Reports from the Consuls. Nos. 75–85 and report of forestry in Europe. The Department.

Treasury Department. Bureau of Statistics, quarterly report. Nos. I–4, 1886–87. Annual report for the year ending June 30, 1886, No. 9. The Department.

Coast and Geodetic Survey, report of the superintendent showing the progress of the work during the fiscal year ending with June 1885. 4to. Washington, 1886.

Commissioner of Navigation, report of, to the Secretary of the Treasury. 1886. 8vo. The Department.

War Department. Annual report of the Chief of Ordnance, June 30, 1886. 8vo. Washington, 1886. The Department.

Vasey, George. Dep. of Agriculture. Report of the Botanist for 1886. 8vo T. Washington, 1887. The Author.

Vejdovsky, Franz. System und Morphologie der Oligochaeten. Fol. Prag, 1884. I. V. Williamson Fund.

Ventenat, E. P. Jardin de la Malmaison. Livr's 1e.–16e. Folio. Paris, 1803, 1804. Thomas Meehan.

Vogt, Carl and Émile Young. Traité d'anatomie comparée pratique. 8e.–10e. L. I. V. Williamson Fund.

Volkens, George. Die Flora der ægyptisch–orabischen Wüste auf Grundlage anatomisch–physiologischer Forschungen. 4to. Berlin, 1887. I. V. Williamson Fund.

Wagner, Franz von. Das Nervensystem von Myzostoma (F. S. Leuckart). 8vo T. Graz, 1886. I. V. Williamson Fund.

Watson, Sereno, Card portrait of. Through the Botanical Section.

Contributions to American botany, XIV. The Author.

Webb, Philip Barker. Iter Hispaniense or a synopsis of plants collected in the southern provinces of Spain and Portugal. 8vo T. Paris, 1838. T. Caruel.

Weber, Max. Studien über Saugethiere. 8vo. Jena, 1886. I. V. Williamson Fund.

Weihe A und Ch. G. Nees von Esenbeck. Die deutschen Brombeerstrauche, bescreiben und dargestellt. Folio. Bonnae, 1822. Thomas Meehan.

Wells, John Grant. A Catalogue of the birds of Grenada, West Indies, with observations thereon. 1887. 8vo T. The Author.

Westerlund, Carl Agardh. Fauna der in palåarctischen Region lebenden Binnenconchylien. III, VI. 8vo. Lund, 1886. I. V. Williamson Fund.

Wharton, Francis. A digest of the international law of the United States. 3 Vols. 8vo. Washington, 1886. The Author.

Whiteaves, J. F. On some marine invertebrata dredged or otherwise collected by Dr. G. M. Dawson in 1885, on the coast of British Columbia. 4to. T. Montreal, 1887. The Author.

Whitman, Charles O. Methods of research in microscopical anatomy and embryology. 8vo. Boston, 1885. I. V. Williamson Fund.

Whitney, J. D. Letter of the State Geologist (California) relative to progress, 1866–7. 8vo T. Sacramento, 1867. In Exchange.

Widhalm, J. Die fossilen Vogel-Knochen der Odessar-Steppen-Kalt-Steinbrüche an der neuen Slobvdka bei Odessa. (Beilage z. X Bd. Schrift. d. neurus. Gesell. der Naturf. zu Odessa). 1886. 4to T. The Society.

Wiedersheim, R. Der Bau des Menschen als Zeugniss für seine Vergangenheit. 8vo. Freiburg i.B., 1887. I. V. Williamson Fund.

Wigand, Albert. Botanisches Heft, 2es. H. I. V. Williamson Fund.

Wight, Robert. Illustrations of Indian botany. 2 vols. 4to. Madras, 1840. I. V. Williamson Fund.

Wolle, Rev. Francis. Fresh-water algæ of the United States. 2 vols. 8vo. Bethlehem, 1887. I. V. Williamson Fund.

Yale University, Catalogue 1886–87. The University.

Zetetic Society. Chart and compass, sextant and sun-dial etc.? 8vo. London, n. d. The Socie

Zoologisches Station von Neapel. Fauna und Flora des Golfes von Neapel. Monogr. XIV. I. V. Williamson Fund.

Zuckerkandl, E. Das Periphere Geruchsorgan der Säugethiere. 8vo. Stuttgart, 1887. I. V. Williamson Fund.

Journals and Periodicals.

Albany. Albany Institute. Transactions XI. The Society.

New York State Library. 67th, 68th and 69th reports. The Trustees.

New York State Museum of Natural History. 32nd, 38th and 39th aunnal reports. The Trustees.

Regents of the Uuiversity of the State of New York. 9th annual report and Historical Record. The Trustees.

Amiens. Société Linnéenne du Nord de la France. Bulletin, VII, 139–VIII, 174. Memoires, VI. The Society.

Amsterdam. K. Akademie van Wettenschappen. Jaarboek, 1885. Verslagen en Mededeelingen, Afdeeling Natuurkunde, III, 2; Afdeeling Letterkunde, III, 3. Verhandelingen, XXV. The Society.

Angers. Société d'Études scientifiques. Bulletin, XIV, Suppl; XV. The Society.

Société Nationale d'Agriculture, Sciences et Arts. Mémoires, T. 28. The Society.

Anvers. Société Royale de Géographie. Bulletin, XI, 4–XII, 1. The Society.

Auch. Société Francaise de Botanique. Revue de Botanique, Nos. 49–59. The Society.

Auxerre. Société des Sciences historiques et naturelles de l'Yonne. Bulletin, XL. The Society.

Baltimore. American Chemical Journal, VIII, 6–IX, 5. The Editor.

American Journal of Mathematics, IX, 1–X, 1. The Editor.

American Journal of Psychology (Hall) I, 1. The Editor.

Johns Hopkins University. Studies from the Biological Laboratory, III, 9; IV, 1, 2. Circulars Nos. 54–59. Annual report, 11th. The University.

Peabody Institute, 20th annual report. Tse Society.

Basel. Naturforschende Gesellschaft. Verhandlungen, VIII, 1. The Society.

Schweizerische paläontologische Gesellschaft. Abhandlungen, XIII. I. V. Williamson Fund.

Batavia. Natuurkundig Vereen in Nederlandsch Indie. Natuurkundig Tijdschrift voor Nederlandisch Indie, 8e Ser. VII, 1, 3, 4; VIII, 1. The Society.

Bath. Postal Microscopical Society. Journal of Microscopy and Natural Science, IV, 21, 22, 24? Tne Editor.

Belfast. Natural History and Philosophical Society. Proceedings 1885–86. The Society.

Naturalists' Field Club. Annual report, II, 6. The Society.

Berkeley. University of California. Register, 1886–87. The Trustees.

Berlin. K. Akademie der Wissenschaften. Abhandlungen, physikalisches, 1886. Sitzungsberichte, 1887, 1–LIII. The Society.

Archiv für Naturgeschichte, XLI, 6; LII, I, 2, 5. The Editor.

Botanischer Jahresbericht (Just) XI, 2 Abth. 3 H.; XII, 1 Abth. 2 H.; 2 Abth. 2 H. I. V. Williamson Fund.

Botanischer Verein der Provinz Brandenburg. Verhandlungen X–XIII; XV–XXVII; XXVIII, 1868–1886. The Society.

Entomologischer Verein. Deutsche entomologische Zeitschrift. XXX, 2; (Berliner) XXXI. 1. The Society.

Deutscher Fischerei-Verein. Circular, 1886, No. 5–1887, No. 3. Mittheilungen 1886, No. 10–1887, No. 5. The Society.

Gartenflora. 1886, 4, 8, 10–24. Thomas Meehan.

Deutsche geologische Gesellschaft. Zeitschrift XXXVIII, 3–XXXIX, 1. Katalag der Bibliothek, April 1887. The Society.
K. P. geologische Landesanstalt und Bergakademie. Jahrbuch, 1885. The Society.
Gesellschaft Naturforschender Freunde. Sitzungs-Bericht, 1886, No. 9–1887, No. 8. The Society.
Jahrbucher für wissenschaftliche Botanik. XVII, 4–XVII, 3. I. V. Williamson Fund.
Naturæ Novitates. 1886, No. 23–1887. No. 21. The Publisher.
Berm. Naturforschende Gesellschaft. Mittheilungen 1143–1168. The Society.
Besancon. Académie des Sciences, Belles-Lettres et Arts. 1885. The Society.
Birmingham Philosophical Society. Proceedings, V. 1. The Society.
Bistritz. Gewerbeschule. Jahresbericht, 12er. The Director.
Bologna. Accademia delle Scienze. Memorie. 4e Ser. VI. The Society.
Bonn. Archiv f. d. gesammte Physiologie etc. (Pflüger). I, 1868–XLI, and Index I–XXX.
Archiv für mikroskopische Anatomie, XXVIII, 3–XXX, 3. I. V. Williamson Fund.
Naturhistorischer Verein. Verhandlungen XLIII, 2. The Society.
Bordeaux. Société Linnéenne. Actes, XXXIX. The Society.
Boston. American Academy of Arts and Sciences. Proceedings XXII, 1 and 2. Memoirs XI, Part IV, No. 5. The Society.
Journal of Morphology, I, 1. I. V. Williamson Fund.
Society of Natural History. Proceedings, XXIII, pp., 305–368. The Society.
Braunschweig. Archiv für Anthropologie XVI, 4; XVII, 1, 2. I. V. Williamson Fund.
Naturwissenschaftliche Rundschau I, 51–II, 50. The Editor.
Zeitschrift für wissenschaftliche Mikroscopie III, 3–IV, 2. I. V. Williamson Fund.
Bremen. Naturwissenschaftliche Verein. Abhandlungen IX, 4. The Society.
Brescia. Ateneo. Commentari, 1886. The Society.
Brooklyn. Entomologia Americana. II, 9–III, 7. The Editor.
Library. Annual report, 29th. The Librarian.
Brünn. K. K. mahrisch-schlesische Gesellschaft zur Beförderung des Ackerbaues, der Natur-und Landes-kunde. Mittheilungen, 1886. The Society.
Naturforschender Verein. Verhandlungen XXIV, 1, 2. Bericht der meteorologischen Commission, 1884. The Society.
Bruxelles. Académie Royale des Sciences, des Lettres et des Beaux Arts de Belgique. Memoires couronnes, 4to T. 47 and 48. Mem. Cour. 8vo T. 37, 38, 39. Memoires, T. 46. Notices Biographique etc., 1886. Catalogue des Livres de la Bibliothèque. 1re Partie; 2e Partie, Lettres, Sciences. Bulletin, 3e Ser., XI, 7–XIII, 10. Annuaire, 1887. The Society.
Musée Royale d'Histoire Naturelle de Belgique. Bulletin IV, 4. The Society.
Société Royale de Botanique. Bulletin, XXV, 2. The Society.
Société Entomologique de Belgique. Annales, XXX, Compte-Rendu. Ser. III, 72–90. The Society.
Société Belge de Geographie. Bulletin, X, 2–XI, 4. The Society.
Société Malacologique. Annales XXI. Procès Verbaux, 8 Jan–3 Juil., 7 Aout–4 Dec. 1887. The Society.
Société Belge de Microscopie. Bulletin XII, 11; XIII, 2–11. The Society.
Budapest. Magyar Tudomànyos Akadémia. Archæologiai Ertesitö, V, 3–5; VI. 1, 2. Ertekezesek a mathematikai Tudomanyok Körébol, XI, 10–XII. 11. Ertekezesek a Termeszettudomanyok Köréböl, XIV, 9; XV, 1, 3–18. Mathematikai es Termeszettudomanyi Közlemenyek vonatkozolog a hazai Viszonyokra XX, 1, 3–5; XXI, 1. Mathem es Termesz. Értesitö, III, 6–IV, 6. Mathem. u Naturw. Berichte aus Ungarn, III. The Society.
Ungarisches National-Museum Termeszetrajzi, Fuzetek. X, 4; XI, 4. Vezeték, 1877–1886. The Director.

Buenos Aires. Sociedad Cientifica Argentina. Anales XXII, 4–XXIV, 1.
Sociedad Geografica Argentina. Revista, No. 42–50. The Society.
Caen. Académie nationale des Sciences, Arts et Belles-Lettres. Memoires, 1886. The Society.
Calcutta. Asiatic Society of Bengal. Journal LV, Pts. 2, Nos. 3 and 4. Proceedings, 1886 Nos. 8 and 9; 1887, Nos. 1–3–5. The Society.
Cambridge. Appalachian Mountain Club. Appalachia IV, 4. Register, 1887. The Society.
Harvard University. Library Bulletin, Nos. 36–38. Bibliographical Contributions, 25. The University.
Museum of Comparative Zoology. Bulletin XIII, 1–5. Memoires XVI, 1, 2. Report 1885–86; 1886–87. The Director.
Peabody Museum of American Archæology and Ethnology. 20th Annual report. The Director.
Cambridge, England, University. Studies from the Morphological Labratory, II, 2; III, 1. The University.
Canada, Royal Society of. Proceedings and Transactions, IV. The Society.
Cap Rouge. Le Naturaliste Canadien, XVI, 7–XVII, 5. The Editor.
Cardiff. Cardiff Naturalists' Society. Report and Transactions, XVIII. The Society.
Catania. Accademia Gioenia di Scienze Naturali. Atti, 3a Ser. XIX. Addunanza del 17 Ottob, 1887. The Society.
Cassel. Malakozoologische Blätter, IX, 2; X, 1. I. V. Williamson Fund.
Verein für Naturkunde. 32er and 33er Bericht. The Society.
Cedar Rapids. Iowa Agricnltural College. Bulletin, Nov. 1886. The College.
Champaign. Illinois State Laboratory of Natural History. Bulletin, II, 6. The Director.
Charleston. Elliot Society of Science and Art. Proceedings, II, pp. 81–120. The Society.
Chicago. Chicago Public Library. 15th Annual report. The Librarian.
The Open Court. I. 1, 2, 4. The Editor.
Ridgway Ornithological Club. Bulletin Nos. 1 and 2. The Society.
American Antiquarian, VII, 1; IX, 1–5. The Editor.
Christiania. Archiv for Mathematik og Naturvidenskab. XII, 1. The Editor.
Videnskab-Selskab. Forhandlinger, 1886. The Society.
Chur. Naturforschende Gesellschaft. Jahresbericht XXIX. The Society.
Cincinnati. Society of Natural History. Journal, IX, 4–X, 3. TheSociety.
Copenhagen. Botaniske Forening. Meddelelser II, 1. Botaniske Tidsskrift, XV, 4e–XVI, 3. The Society.
Naturhistoriske Forening. Videnskabelige Meddelelser, 1884–86. The Society.
K. D. Videnskabernes Selskab. Oversigt 1886. No. 2; 1887, 1. Skrifter, II, 2; III, 4; IV, 2, 3. The Society.
Corboda. Academia nacional de Ciencias exactas. Boletin, IX, 1, 2, 4. Actas. V, 3. The Society.
Crawfordsville. Botanical Gazette. XI, 12–XII, 11. The Editor.
Danzig. Naturforschende Gesellschaft. Schriften. N. F. VI, 4. The Society.
Darmstadt. Verein für Erdkunde. Notizblatt, 3e Folge, IV, 7. The Society.
Denver. Colorado Scientific Society. Proceedings, II, 2. The Society.
Detroit. The Microscope, VII, 1. The Editor.
Dorpat. Naturforscher Gesellschaft. Sitzungsberichte VIII, 1. Archiv für die Naturkunde Liv-Ehst-und Kurlands 2e Ser., IX, 4.
Dresden. K. mineralogisch-geologisches und præhistorisches Museum. Mittheilungen No. 7. The Director.
Naturwissenschaftliche Gesellschaft Isis. Sitzungsberichte und Abhandlungen, 1886, Juli-Dec.; 1887. Jan–Juni. The Society.
Dublin. Royal Geological Society of Ireland. Journal XVIII, 1. The Society.,
Royal Dublin Society Proceedings, N. S. V, 3, 4, 5, 6.; Transactions, Ser. II, Vol. III, 11–13. The Society.

Royal Irish Academy. Proceedings, Science, Ser. II, Vol. 4, No. 5; Polite Literature and Antiquities, Ser. II, Vol. 2, No. 7. Transactions, Science, XXVIII, 21-25; Polite Literature and Antiquities, XXVII, 6, 7, 8; Cunningham Memoirs, II, III. The Society.
Science and Art Museum. Report of Director. 1887. The Society.
Dunedin, N. Z. New Zealand Journal of Science, I, 2. I. V. Williamson Fund.
Edinburgh. Botanical Society. Transactions and Proceedings XVI, 3. The Society.
Geological Society. Transactions, V, 2, 3 and Catalogue of the Library. The Society.
Royal Physical Society. Proceedings, 1885-86. The Society.
Elberfeld. Naturwissenschaftliche Verein. Jahres-Berichte, 7es H. The Society.
Emden. Naturforschende Gesellschaft. Jahresbericht, 71 er. The Society.
Erfurt. K. Akademie gemeinutziger Wissenschaften. Jahrbucher, n. F. H. 14. The Society.
Erlangen. Biologisches Centralblatt. VI, 18-VII, 17. I. V. Williamson Fund.
Physikalisch-medicinische Societät. Sitzungsberichte H. 18. The Society.
Florence. Biblioteca nazionale central. Bolletino, 1886, Nos. 22-45. The Librarian.
Nuovo Giornale Botanico Italiano. (Caruel.) XIX, 1-4. The Editor.
Società Entomologica Italiana. Bolletino, XVIII, 4; XIX, 1, 2. The Society.
Società Italiana di Antropologia, Etnologia e Psicologia comparata. Archivio, XVI, 2, 3; XVII, 1, 2. The Society.
Folkestone. Natural History Society. Oct. 1886-June, 1887. The Society.
Frankfurt a/M. Deutsche malakozoologische Gesellschaft. Jahrbücher, XIII, 4-XIV, 3-1887, No. 10. Nachrichtsblatt, 1886, No. 11. The Society.
Frankfurter Verein für Geographie und Statistik. Jahresbericht, Jahrg. L. Beitrage zur Statistik V, 1. The Society.
Physikalischer Verein. Jahresbericht, 1884-85; 1885-86. The Society.
Senckenbergische Naturforschende Gesellschaft. Bericht 1886, 1887. Abhandlungen XIV, 2, 3. The Society.
Frankfurt a/O ·Naturwissenschaftlicher Verein. Monatliche Mittheilungen, IV. 1-10. The Society.
Societatum Litterae. 1887. Nos. 1-10. The Editor.
Freiburg, i. B. Naturforschende Gesellschaft. Berichte I, The Society.
Gand. Archives de Biologie. Van Beneden and Van Bambeke, VI, 3, 4. I. V. Williamson Fund.
Geneva. Institut National Genevois. Memoires, XVI. The Society.
Recueil Zoologique Suisse (Fol) IV, 1-3. I. V. Williamson Fund.
Genoa. Società di Letture e Conversazione Scientifiche. Giornale, IX, 9, 11, 12; X, 1e Sem. 3, 4. The Society.
Giessen. Jahresbericht über die Fortschritte der Chemie. (Fittica). 1884, No. 4-1885, No. 3. The Editor.
Oberhesische Gesellschaft für Natur-und Heilkunde, 25er Bericht. The Society.
Glasgow. Natural History Society. Proceedings, n. s. I, 3.
Philosophical Society. Proceedings, XVII. The Society.
Görlitz. Naturforschende Gesellschaft. Abhandlungen, XIX. The Society.
Oberlausitziche Gesellschaft der Wissenschaften. Neues lausitziches Magazin, LXII, 2; LXIII, 1. The Society.
Golden, Colorado. State Board of Mines. Biennial report, 1886. The Director.
Gotha. Dr. A. Peterman's Mitteilungen aus Justus Perthe's geograpischer Anstalt XXXII, 11-XXXIII, 10. Erganzungsheft No. 84-87. Inhaltsverzeichniss, 1875-84. I. V. Williamson Fund.
Granville, Ohio. Denison University. Bulletin of the Scientific Laboratories, II, 1, 2. The Trustees.
s'Gravenhage. De Nederlandsche entomologische Vereeniging. Tijdschrift voor Entomologie, XXIX. 3 H.-XXX, 1. The Society.

Graz. Botanisches Institute (Leitgeb). Mittheilungen H. 1. I. V. Williamson Fund.
Naturwissenschaftliche Verein für Steiermark. Mittheilungen, 1886.
Verein der Arzte in Steiermark. Mittheilungen, 1886.
Zoologisches Institut. Arbeiten I, 2–II, 2. I. V. Williamson Fund.
Groningen. Natuurkundige Genootschap. Verslag, 1886. The Society.
Güstrow. Verein der Freunde der Naturgeschichte in Mecklenberg. Archiv XL. 1886. The Society.
Halifax. Nova Scotian Institute of Natural Sciences. Proceedings and Transactions. VI, 4. The Society.
Halle. Naturforschende Gesellschaft. Abhandlungen, XVI, 4. Bericht, 1885, 1886.
Halle a/S. Verein für Erdkunde. Mittheilungen, 1886. The Society.
Zeitschrift für Naturwissenschaften, 4e F. V, 3–VI, 1. The Editor.
Hamburg. Naturhistorisches Museum. Bericht, 1885. The Director.
Naturwissenschaftlicher Verein. Abhandlungen, IX, 1, 2. The Society.
Musée Teyler. Archives, 2nd Ser. II, 4. Catalogue de la Bibliotheque III, and IV.
Société Hollandaise des Sciences. Archives XXI, 2–5; XXII, 1. Verhandlungen, 3e Verz. IV. 4. The Society.
Helsingfors. Finska Vetenskaps-Societeten. Ofversigt XXVII. Observations Metéorologiques 1882, 1883. The Society.
Hermannstadt. Siebenbürgischer Verein für Naturwissenschaften. Verhandlungen und Mittheilungen XXXVII. Archiv. XXI, 1. Jahresbericht, 1885–6. The Society.
Iowa City. State Historical Society. Iowa Historical Record, Jan.–Oct., 1887. The Society.
Jena. Anatomischer Anzeiger. II, 16–23. The Editor.
Medicinisch-naturwissenschaftliche Gesellschaft. Zeitschrift XX, 1–XXI, 2. The Society.
Zoologische Jahrbücher. II, 1–4. I. V. Williamson Fund.
Kharkow. Société des Naturalistes à l'Université impériale. Travaux, XX. The Society.
Klagenfurt. Landesmuseum, Diagramme der magn. u. meteor. Beobachtungen, 1885–1886. Jahrbuch, 18. Bericht, 1885. Carinthia, 1886, No. 12–1887, No. 10. The Society.
Konigsberg. Physikalisch-ökonomische Gesellschaft. Schriften, XXVII.
Landshut. Botanischer Verein. Bericht, 1886–87. The Society.
Lausanne. Société Vaudoise des Sciences Naturelles. Bulletin, 94, 95.
Leeds. Journal of Conchology. V, 4. 5, 6. The Editor.
Philosophical and Literary Society. Annual report, 1886–7. The Society.
Yorkshire Geological and Polytechnic Society. Proceedings, N. S. IX, 2. The Society.
Yorkshire Naturalists' Union. Transactions, IX, 1884. The Society,
Leyden. Museum, Notes (Jentink) VIII, 1–4. The Editor.
Nederlandsche Dierkundige Vereeniging. Tijdschrift, 2e Ser. I, 4. The Society.
Leipzig. Archiv f. Anatomie und Physiologie. Anat. Abth. 1886, Nos. 5 and 6; 1887, 1–3. Physiol. Abth. 1886; Suppl. Bd. 1887, 1–4.
Botanische Institut zu Tübingen. Untersuchungen II, 2. I. V. Williamson Fund.
Botanische Jahrbücher (Engler) VIII, 2–5; IX, 1.
Botanische Zeitung. XLV, 4–6; XLIV, 1–3. I. V. Williamson Fund.
Jahresberichte ü. d. Fortschritte der Anatomie und Physiologie. 14er Bd. II, Abth. 1. I. V. Williamson Fund.
Journal für Ornithologie, XXXIV, 2–XXXV, 2. I. V. Williamson Fund.
K. sächsische Gesellschaft der Wissenschaften. Adhandlungen XIII, 6–9. Bericht, 1886, I—IV, Suppl. The Society.
Morphologisches Jahrbuch, XII, 3–XIII, 1. I. V. Williamson Fund.

Verein für Erdkunde. Mittheilungen, 1885. The Society.
Zeitschrift für Krystallographie und Mineralogie. Groth. XII, 4–XIII, 4. I. V. Williamson Fund.
Zeitschrift für wissenschaftliche Zoologie, XLIV, 3–XLV, 4. I. V. Williamson Fund.
Zoologische Station. Zoologischer Jahresbericht, 1885, 1, IV. I. V. Williamson Fund.
Zoologischer Anzeiger, Nos. 237–264. I. V. Williamson Fund.
Liege. Société Royale des Sciences. Memoires, XIII. The Society.
Lille. Société Géologique du Nord. Annales, XIII. The Society.
Lisbon. Associacao dos Engenheiros Civis Portugueses. Revista de Obras publicas e Minas. 195–214. The Society.
La Revue du Portugal et de ses Colonies 1887, Jan. Feb. The Editor.
Liverpool. Free Public Library, Museum and Walker Art Gallery. 34th annual report. The Trustees.
Geological Society. Proceedings, V, 3. The Society.
Literary and Philosophical Society. Proceedings, Vols. 39 and 40. The Society.
Annals and Magazine of Natural History, 5th Ser. Nos. 108–119. I. V. Williamson Fund.
Anthropological Institute. Journal XVI, 3–XVII, 2. The Society.
Astronomical Register, No. 288. I. V. Williamson Fund.
British Association for the Advancement of Science. Report 55th and 56th Meetings. I. V. Williamson Fund.
Chemical Society, Abstract of Proceedings. Nos. 28–42. Journal 289–299. The Society.
Curtis's Botanical Magazine. Nos. 1198–1209. I. V. Williamson Fund.
The Earth. Nos. 4–6, 8–10. 12, 13, 17. The Editor.
The Electrician XVII, XIX, 28. The Editor.
Entomological Society. Transactions, 1886. No. 4–1887, No. 3. The Society.
Gardeners' Chronicle, 2nd Ser. No. 674—3rd Ser. I, 47. The Editor.
Geological Magazine. Nos. 270–281. I. V. Williamson Fund.
Geological Society. Quarterly Journal. Nos. 168–171; List, 1885. The Society.
Geologists' Association. Proceedings IX, 7, 8; X, I and 2. The Society.
Grevillea (Cooke). I—XIV, 1880–86, XV, 73–77. Executors of Dr. Geo. Martin.
Hardwicke's Science Gossip. No. 264–275. I. V. Williamson Fund.
The Ibis. 5th Ser. II, 17–20. I. V. Williamson Fund.
Journal of Botany, British and Foreign. Nos. 288–299.
Journal of Physiology. VIII, 1–5. I. V. Williamson Fund.
Knowledge IX, 9–12; X, 13–25. The Editor.
Linnean Society Journal. Botany 140, 145–149, 151, 158; Zoology, 114–117, 126–129. Proceedings, Oct. 1886, July, 1887. Transactions, 2nd Series; Zoology IV, 1, 2; Botany II, 9-14. List, 1886–1887. The Society.
London, Edinburgh and Dublin Philosophical Magazine. 5th Series, Nos. 139–150. I. V. Williamson Fund.
Mineralogical Society of Great Britain and Ireland. Mineralogical Magazine, Nos. 33 and 34. I. V. Williamson Fund.
The Naturalist, Nos. 137–148. The Editor.
Nature, Nos. 891–942. The Editor.
Paleontographical Society. Publications, Vol. VL. Wilson Fund.
Physical Society. Proceedings VIII, 3; IX, 1. The Society.
Quarterly Journal of Microscopical Science. 5th Series No. 107; N. S. No. 109. I. V. Williamson Fund.
Queckett Microscopical Club. Journal Nos. 36–48; II Ser. Nos 1–19; Gen. Index. I–VI; Catalogue of microscopical preparations; Catalogue of books, The Society.

London. Royal Institution of Great Britain Proceedings XI, 3. List, 1886. The Society.
Royal. Proceedings, Nos. 248–258. Philosophical Transactions, 177, Parts 1 and 2. List, 30th, Nov. 1886.
Royal Geographical Society. Proceedings, n. s. VIII, 12–IX, 11. The Society.
Royal Microscopical Society. Journal VI, 2nd Ser. 6a; 1887, 1–4. The Society.
Scientific Enquirer, II, 1–2. The Editor.
London Society of Arts. Journal, XXXIV. The Society.
Trübner's American and Oriental Literary Record. Nos. 229–234. The Publishers.
Zoological Record. 1885. I. V. Williamson Fund.
Zoological Society. Proceedings, 1886 No. 4–1887, No. 3. Transactions XII, 4, 5, 6. The Society.
Zoologist. 3rd Ser. Nos. 120–131. The Editor.
London, Ca. Canadian Entomologist. XVIII, 10–XIX, 11. The Editor.
Louvain. University Catholique. Liber Memorialis, 1834–1884. Choix de Mémoires, XIII. Annuaire XLI. Thirteen theses. The Society.
Lübeck. Naturhistorische Museum. Jahresbericht, 1885, 1886. The Society.
Lüneburg. Naturwissenschaftlicher Verein. Jahreshefte, X. The Society.
Lund. University. Acta. XXII. The University.
Luxembourg. Institut Royal. Publications XX. The Society.
Madrid. R. Academia de Ciencias exactas, fisicas y naturales. Memorias XI. Revista, XXII, 2, 3. The Society.
Sociedad Geografica. Boletin, XXI, 3–6; XXII, 3–6? The Society.
Magdeburg. Naturwissenschaftlicher Verein. Jahresbericht u. Abhandlungen, 1886. The Society.
Malton. Malton Field Naturalists' and Scientific Society. 3rd Annual Report. The Society.
Manchester. Geological Society. Transactions, XIX, 2–10. The Society.
Microscopical Society. Transactions 1886. The Society.
Scientific Students' Association. Annual report, 1885, 1886. The Society.
Meriden, Conn. Scientific Association. Transactions II. The Society.
Metz. Société d'Histoire Naturelle. Bulletin, 2e Ser. 16 and 17 Cah. The Society.
Verein für Erdkunde, 9er Jahresbericht. The Society.
Mexico. Museo Nacional. Anales, III, 10, 11; IV, 1. The Director.
Sociedad Cientifica "Antonio Alzate." Memorias, I, 2–4. The Society.
Sociedad de Geografia y Estadistica. Boletin VI, 4–9. The Society.
Sociedad Mexicana de Historia Natural. La Naturaleza, VII, 16–24; 2d Ser. I, 1. The Society.
Middelburg. Zeeuwsch Genootschap der Wetenschappen. Archief VI, 2. The Society.
Middleton, Wesleyan University. Report, 15th. The Society.
Milan. R. Istituto Lombardo di Scienze, Lettere ed Arti. Rendiconti, Ser. II, XIX, 12,—XX, 18? The Society.
Modena. Società dei Naturalisti. Atti, Ser. III, Vol. III, pp. 1–48; Vol. IV. The Society.
Mons. Société des Science, des Arts et des Lettres du Hanaut. Mémoires et Publications IVme Ser. T. 9me. The Society.
Montreal. Canadian Record of Science, II, 5–8. The Editor.
Moscow. Société Impériale des Naturalistes. Bulletin, 1886, 2–4: Beilage, I, XII. The Society.
Münster. Westfälischer Provinzial-Verein fur Wissénschaft und Kunst. Jahresbericht, 14er. The Society.
Munich. Gesellschaft für Anthropologie, Ethnologie und Urgeschichte. Beitrage, VII, 3–4. The Society.
Zeitschrift für Biologie, XXIII, 3–XXIV, 1. I. V. Williamson Fund.

Nancy. Société des Sciences. Bulletin, Serie 2me, III, 19. The Society.
Naples, R. Accademia delle Scienze fisiche e matematiche, XXV, 4–12.
R. Istituto d'Incoraggiamento alle Scienze Naturali economiche e technologiche. Atti, 3er Ser. V. The Society.
Zoologische Station. Mitthelungen VII, 1, 2. Zoologischer. Jahresbericht, 1885, II. The Director.
Neuchatel Société des Sciences Naturelles. Bulletin, XV. The Society.
Newcastle-upon Tyne. Natural History Society of Northumberland, Durham and Newcastle upon-Tyne. Transactions, VIII, 2; IX, 1. The Society.
New Haven. Connecticut Academy. Transactions VII, 1. The Society.
The American Journal of Science No's. 193–203. The Editor.
New York. Academy of Sciences. Annals, III, 12; IV, 1, 2. Transactions IV, V, 7 and 8. The Society.
Astor library, annual report, 38th. The Trustees.
The Auk, IX, 1–4 and Index. The Editor.
American Bookseller XX, 5. The Editor.
The American Chemist, VII, 10. The Editor.
Cooper Union, 26th, 27th and 28th annual reports. The Trustees.
Forest and Stream, XXVII, 19–XXIX, 18. The Editor.
The Forum. III, 1. The Editor.
American Geographical Society. Bulletin, 1885, No. 3, 1887 No. 3. The Society.
Library Journal, XI, 12–XII, 11. I. V. Williamson Fund.
Literary News, VII, 12–VIII, 11. The Editor.
Mercantile Library Association of the City of New York, 66th annual report. Bulletin, No. 9. The Librarian.
New York Medical Journal, XLIV, 23–XLVI, 22. The Editor.
Am. Museum of Natural History. Bulletin II, 1. Annual Report, 1886–7. The Society.
Pharmaceutical Association. Proceedings, 9th Meeting. The Society.
Popular Science Monthly, Jan.–Dec. 1887. The Editor.
Science, No's. 200–251. I. V. Williamson Fund.
Swiss Cross, I, 1. The Editor.
Torrey Botanical Club. Bulletin, XIII, 12–XIV, 11. The Society.
Nijmegen. Nederlandsche Botanische Vereeniging. Nederlandsch Kruidkundig Archief, 4e Serie V, 1. The Society.
Nürmberg. Naturhistorische Gesellschaft. Jahresbericht, Abhandlungen, VIII, 4, 5. The Society.
Odessa. Société des Naturalistes de la Nouvelle Russie. Memoirs, XI, 2. The Society.
Omaha. Omaha Public Library, 10th Annual report, The Librarian.
Ottawa. Ottawa Field-Naturalists' Club. Transactions, No. 7. Ottawa Naturalist, I, 1–8. The Society.
Oxford. Annals of Botany, I, 1. I. V. Williamson Fund.
Padova. Società Veneto-Trentina di Scienze Naturale. Atti. X, 1. Bollettino, IV, 1. The Society.
Palermo. Reale Accademia di Scienze, Lettere e Belle Arti. Bullettino, III, 1–3. The Society.
R. Istitute Technico superiore. Programma, 1866–67. The Society.
Il Naturalista Siciliano, VI, 3–VII, 2. The Editor.
Paris. Annales des Mines. 8me Ser. IX, 5, 6; XI, 1, 2, 3. Minister of Public Works in France.
Annales des Sciences Naturelles, Zoologie et Palæontologie, 7me, Ser. I, 1–6; II, 1–6; Botanique 7me, Ser. IV, 5, 6; V, 1–6; VI, 1. I. V. Williamson Fund.
Archives de Zoologie experimentale et générale, 2me Ser. IV, 4; V, 1. 2. I. V. Williamson Fund.
École polytechnique. Journal, 56. The Society.
Institution Ethnographique. Bulletin de l'Alliance Scient. Univ. 72, 73.
Journal de Conchyliologie, XXVI, 1. The Editor

Journal de Micrographie, X, 11–1887, 14. The Editor.
Le Naturaliste, 1886, No. 47–2me, Ser. 17. The Editor.
Revue d'Ethnographie, V, 4–VI, 2. I. V. Williamson Fund.
Revue Geographique, No. 132–134, 136–139, 141. The Editor.
Revue Scientifique, XXXVIII, 22–25. The Editor.
Société d'Acclimatation. Bulletin, 4e, Ser. III, 8, 12–IV, 1, 2, 5–7, 9–12; No. Supplem. The Society.
Société nationale d'Agriculture de France. Bulletin, 1886, No. 10,–1887, No. 9. The Society.
Société de Biologie. Compte Rendu des Séances, 1886, No's. 16, 27, 40,–1887, No. 35. The Society.
Société Geologique de France. Bulletin, 3e. Ser. XIV, 6,–XV, 3. The Society.
Société Malacologique de France. Bulletin, No. 2, Dec. 1886. Annales XX. Proces-Verbaux, 1886, Jan. 9 July 4. Statuts. Revue Biographique, 1886. The Society.
Société Francaise de Minéralogie. Bulletin, IX, 8–X, 6. The Society.
Société Philomathique. Bulletin, 7me, Ser. X, 3–XI. The Society.
Société Zoologique. Bulletin, 1886, No's. 4–6; 1887, No's. 1, 2. The Society.

Pawtucket. Free Public Library, Annual report, 1886. The Librarian.
Peoria. Scientific Association. Bulletin, 1887. The Society.
Perth. Scottish Naturalist. N. S. No. 14, 16–18. The Editor.
Philadelphia. Academy of Natural Sciences, Proceedings 1886, III–1887, II.
American Entomological Society, Transactions, XIII, 3, 4; XIV, 1; Supplement, 1887, I. The Society.
Am. Journal of the Medical Sciences, Jan.–Oct. 1887. The Editor.
American Journal of Pharmacy. XVI, 12, XVII, 11. The Editor.
American Naturalist, XX, 12,–XXI, 10. The Editor.
American Philosophical Society. Proceedings 124, 125. The Society.
College of Pharmacy. Alumni Association. Annual report, XXIII. The Society.
The Conchololgists' Exchange, I, 6, 8, 10,–12; II, 1–4. The Editor.
The Dental Cosmos., XXVIII, 12–XXIX, 11. The Editor.
Engineers' Club. Proceedings, VI, 1, 2. The Society.
Franklin Institute. Journal, No. 732–743. The Society.
Gardener's Monthly. Dec. 1886–Nov. 1887. The Editor.
Historical Society of Pennsylvania. Pennsylvania Magazine of History and Biography, X, 4.–XI, 3. The Society.
Journal of Comparative Medicine and Surgery, VIII, 1–4. I. V. Williamson Fund.
Library Co. of Philadelphia. Bulletin, Jan., July–Sept. 1887. The Librarian.
Medical and Surgical Reporter, LVI, 22–LVII, 22. The Editor.
Mercantile Libr. Co., Report, 1887. The Librarian.
Microscopical Bulletin, June,–Oct. 1887. The Editor.
Naturalists' Leisure Hour., Dec. 1886.–Sept. 1887. The Editor.
Polyclinic. IV, 6–V, 5. The Editor.
Society for Organizing Charity. Annual report, 8th. The Society.
University of Pennsylvania. Department of Biology, Announcement for session 1887–88.
Wagner Free Institute of Science. Transactions, I, 1887. The Trustees.
Zoological Society, 15th annual report. The Society.

Pisa. Società Malacologica Italiana. Bulletino, XII, 5–15. Society.
Società Tosc. di Scienze Naturali. Atti, Processi Verb. V, 119–263, VII, 2, Memorie, VIII, 1. The Society.

Pittsburg. The Bookmart, IV, 42. The Publishers.
Poughkeepsie. Vassar Brothers Institute Transactions, IV. The Director.
Prag. Deutscher Verein zur Verbreitung gemeinnütziger Kenntnisse. Sammlung gemeinnütziger Vörtrage, No. 114. The Society.
Lotos. VII. The Editor.

Raleigh. Elisha Mitchell Scientific Society. Journal 1885–86. The Society.
Regensburg. K. B. botanische Gesellschaft. Flora, n. R. 44. The Society.
NaturwissenschaftlicherVerein. Correspondenz-Blatt, 40. The Society.
Reichenbach, IV. Verein für Naturkunde. Mittheilungen, 5es H. The Society.
Riga. Naturforscher-Verein. Correspondenzblatt, 29er, Jahrg. The Society.
Rio Janeiro. Museu Nacional. Archivos, III, 1, 2. The Director.
Observatoire. Revista, I, 11–II, 9. The Director.
Rochester. Warner Observatory. History and Work, 1883–1886, I. The Director.
Rome. R. Accademia dei Lincei. Serie Quarta, Rendiconti, II, 8–III, 13, 2e, Sem. 1–3. The Society.
Archives Italiennes de Biologie, VII, 3; VIII, 1, 2. Catalogue des Travaux, 1885. I. V. Williamson Fund.
Biblioteca Nazionale Centrale Vittorio Emanuell. Bollettino, I, 5–II, 3. The Librarian.
Società Geographica Italiana. Bollettino, Ser. II, An. XX, 11–XXI, 9. The Society.
Società degli Spettroscopisti Italiani. Memorie, XV, 8–XVI, 8. The Society.
St. Gall. St Gallische naturwissenschaftliche Gesellschaft. Bericht, 1884–85. The Society.
Saint John. Natural History Society of New Brunswick. Bulletin, No. 6.
St. Louis. Academy of Sciences. Transactions, IV, 4. The Society.
St. Petersburg. K. Akademie der Wissenschaften. Bulletin, XXX, 4–XXXI, 2–4. Memoires XXXIV, 4–XXXV, 2. Repertorium für Meteorologie, Supplementband, II–IV. The Society.
Hortus Universitatis Imperialis Petropolitanæ. Scripta Botanica, I, II. I. V. Williamson Fund.
Physikalische Central-Observatorium. Annalen, 1885, 1, 2. The Director.
Imp. russkoye geografitcheskoye Obschtchestvo. Izviestiya, XXII, 6–XXIII, 3. Report, 1886.
Russian Physico-Chemical Society of the University, XVIII, 8, 9. The Society.
Societas Entomologica Rossica. Horae, XX. The Society.
Salem, Essex Institute. Bulletin, XVIII, No's 7–12. The Society.
Peabody Academy of Sciences, 19th annual report. The Society.
San Diego. West-American Scientist, II, 21–29. The Editor.
San Francisco. California Academy of Sciences. Bulletin, No's 6, 7. The Society.
Mercantile Library, 34th annual report. The Tru[illegible].
Santa Barbara. Society of Natural History. Report of Proceedings. Bulletin, No. 1. The Society.
Santiago. Wissenschaftlicher Verein. Verhandlungen, 5 H. The Society.
Semur. Société des Sciences historiques et naturelles, Bulletin. 2e S. No. 2. The Society.
Siena. R. Accademia dei Fisiocritici. Sezione dei Cultori delle Scienze Medici. Bolletino, V, 3–9. The Society.
Springfield, Illinois. Industrial University, 13th report. The Trustees.
Stettin. Entomologischer Verein. Entomologischer Zeitung, XLIV. The Society.
Verein für Erdkunde. Jahresbericht, 1886. The Society.
Stockholm. Entomologiske Tidskrift, VII, 1–4. The Editor.
Geologiska Foreningens. Förhandlingar, VIII, 6–IX, 4. The Society.
Svenska Sällskabet för Anthropologi och Geografi. Ymer. 1886, H. 1–4, 8. The Society.
K. Vetenskaps Akademien. Ofversigt 1885, No. 10; 1886, No, 9; 1887, No's 1–6. Bihang, XI, 1–XII, 4. The Society.
Stuttgart. Humboldt, 1886, No. 12–1887, No. 11. I. V. Williamson Fund.
Kosmos. 1886, II, 4–6. I: V. Williamson Fund.
Verein für vaterländische Naturkunde in Württemberg. Jahreshefte, 43.
Switzerland. Société Helvetique des Sciences Naturelles, 69me Ses. The Society.

Sydney. Linnean Society of New South Wales. Proceedings Ser. I, Vol. 2, No. 1; Ser. II, Vol. 1, No's 2–4; Vol. 2, No. 2. Catalogue of the library, 1886. The Society.
Royal Society of New South Wales. Journal and Proceedings, XIX. The Society.
Tasmania. Royal Society. Papers and Proceedings and Report, 1885. The Society.
Tokio. Medicinische Facultät der kaiserlich-japanische Universität. Mittheilungen, I, 1. The Faculty.
Sei i Kwai. Transactions, Supplement, V, 11–VI, 10. The Society.
University, Literature College. Memoirs, No. 1. The Society.
Topeka. Kansas State Historical Society. Report, 5th biennial; 1887. The Society.
Washburn Laboratory of Natural History. Bulletin, I, 7, 8. The Society.
Toronto. Canadian Institute. Proceedings, n. s. IV, 2; V, 1. The Society.
Entomological Society. Annual Report, 1887. The Society.
Toulouse. Académie des Sciences, Inscriptions et Belles-Lettres. Memoires, 8me, Ser. VIII. The Society.
Revue Mycologique, VII, 33–36. The Editor.
Société d'Histoire Naturelle. Compte rendu sommaire de la séances, 2 Juin, 20 Juil, 1886; Mars 2, 1887. Bulletin, XIX, XX. The Society.
Trenton, Natural History Society. Journal, I, 2. The Society.
Trieste, Società Adriatica di Scienze Naturali. Bollettino, X. The Society.
Tübingen. Der Naturforscher, XIX, 27–XX, 26. The Editor.
Turin, R. Accademia delle Scienze. Memorie, Ser. 2a XXXVII. Atti, XXI, 1–7. The Society.
Osservatorio della Regia Universita. Bollettino, XX. The Director.
Musei di Zoologia ed Anatomia comparata della R. Università. Bollettino, I, 16; II, 19–26. The Society.
United States. American Association for the Advancement of Science. Proceedings, XXXV. The Society.
American Pharmaceutical Association. Proceedings, XXXIV. The Society.
Upsal. Observatoire de l'Université. Bulletin meteorologique, XVIII. The Society.
Utrecht. K. nederlandsch meteorologisch Instituut, Jaarboek, 1878, II; 1886. The Director.
Provinciaal Utrechtsch Genootschap van Kusten en Wetenschappen. Verslag, 1886. Aanteekeningen, 1886. The Society.
Valparaiso. Wissenschaftlicher Verein zu Santiago, 1886, 3 and 4 H. The Society.
Venice. L'Ateneo Veneto. Ser. XI, Vol. I, No. 1–II, 6. The Editor.
R. Istituto Veneto di Scienze, Lettere ed Arti. Atti. Ser. VI, T. III, 10–V, 1. The Society.
Notarisia, I, 5–7. The Editor.
Vienna. K. Akademie der Wissenschaften, Sitzungsberichte, math-naturw Classe, XCII Bd. I Abth. 5–10, II Abth. 4–10, III Abth. 3–10; XCIII Bd. I Abth. 1–5, II Abth. 1–5, III Abth. 1–5.; XCIV Bd. I Abth. 1–5, II Abth. 1–5, III Abth. 1–5; XCV Bd. II Abth. 1, 2. Denkschrift, L, LI, LII. The Society.
Anthropologische Gesellschäft. Mittheilungen, XVI, 1–XVII, 2. The Society.
Congrès internationational d'hygiene et de démographie, 1887. Programme. The Council.
K. K. geologische Reichsanstalt. Verhandlungen, 1886, No. 13–1887, No. 14. Jahrbuch, XXXVI, 2–XXXVII, 1. Abhandlungen, XII, 1–4. The Society.

Mineralogische und petrographische Mittheilungen, (Tschermak), N. F. VIII, 1-IX, 3. I. V. Williamson Fund.
Ornis II, 2-III, 1. I. V. Williamson Fund.
K. k. zoologisch-botanische Gesellschaft. Verhandlungen, XXXVI, 3, 4; XXXVIII, 1, 2. The Society.
Washington. The American Botanical Register, No. 1, 2 and 3. Thomas Meehan.
American Monthly Microscopical Journal, VII, 12-VIII, 10. The Editor.
Chemical Society. Bulletin, No. 2. The Society.
Philosophical Society. Bulletin, IX. The Society.
Smithsonian Institution. Annual Report for 1885, I. Miscellaneous Collections, XXVIII-XXX. The Institution.
United States Fish Commission. Bulletin, VI, VII, 1-7. The Commission.
United States National Museum. Proceedings, VIII, pp. 289 et seq. 1887, sheets 1-24. Annual Reports 1881, 1882 and 1883. The Director.
U. S. Publications. Monthly Catalogue, II, 7-III, 6. I. V. Williamson Fund.
Wellington. New Zealand Institute. Transactions, XIX.
Wiesbaden. Nassauischer Verein für Naturkunde. Jahrbucher, Jahrg. 40. The Society.
Wilkes barre. Wyoming Historical and Geological Society. Proceedings III. Angelo Heilprin.
Worcester. American Antiquarian Society. Proceedings, IV, 3, 4. The Society.
Wurzburg. Botanisches Institut. Arbeiten, III, 3. I. V. Williamson Fund.
Physik.-medicin. Gesellsch. Verhandlungen, XX. Sitzungsberichte, 1886. The Society.
Zoologisch-zootomisches Institut. Arbeiten, VIII, 2. I. V. Williamson Fund.
Yokohama. Asiatic Society of Japan. Transactions, XIV, 2-XV, 2. The Society.
Seismological Society of Japan. Transactions, X. The Society.
Zurich. Naturforschende Gesellschaft. Viertel-Jahrsschrift, XXX, XXXI, 1, 2. The Society.
Zwickau. Verein für Naturkunde. Jahresbericht. 1886. The Society.

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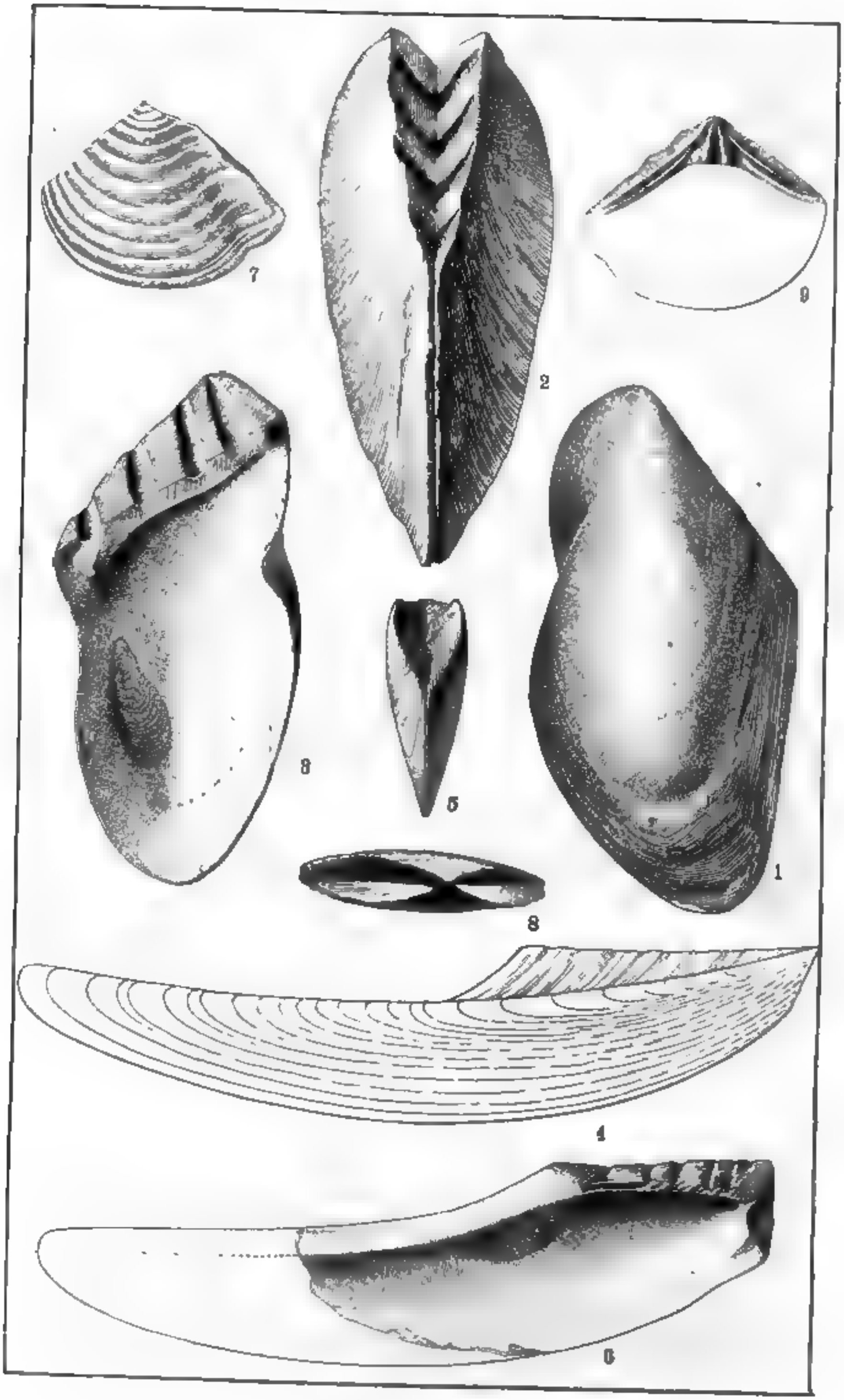

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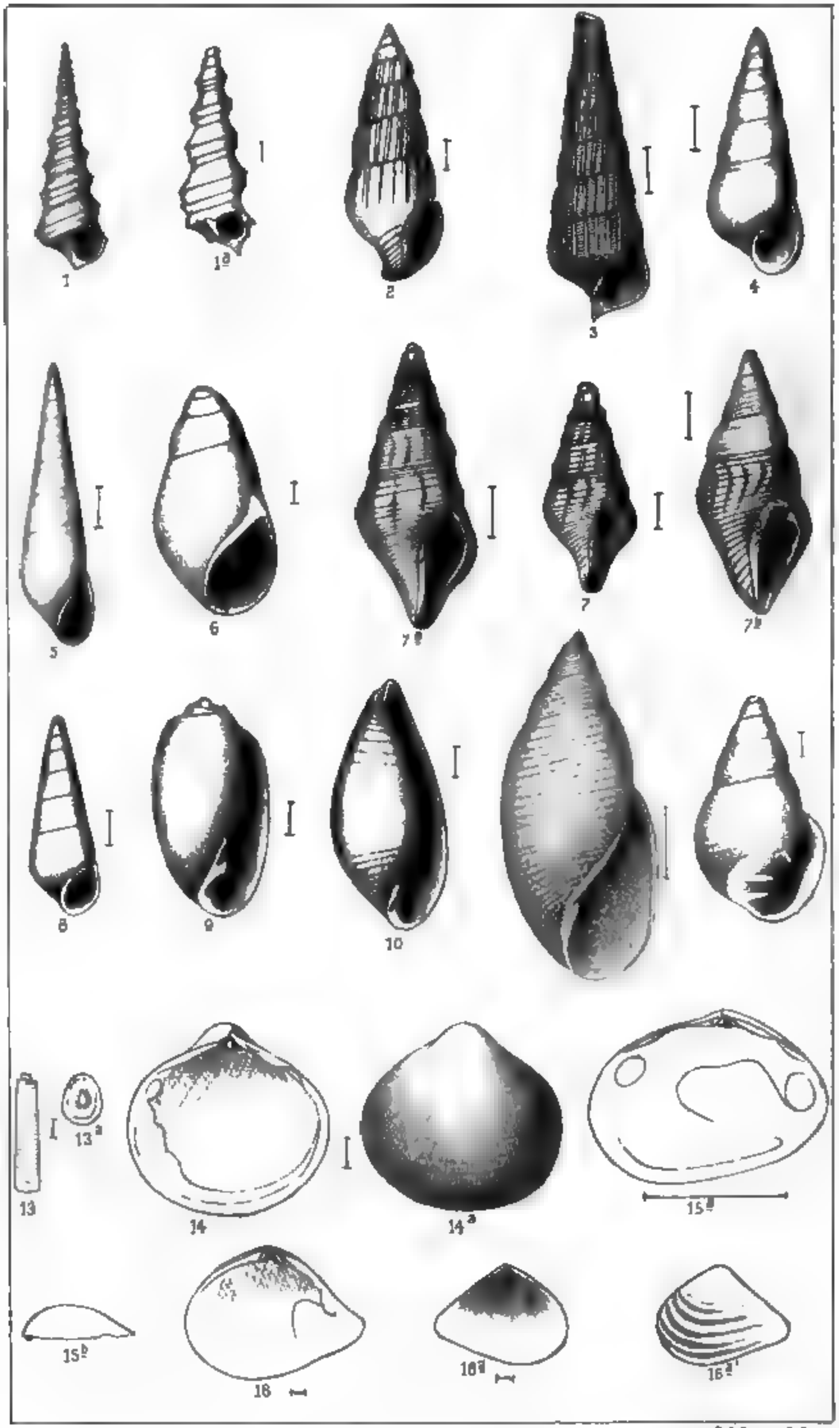
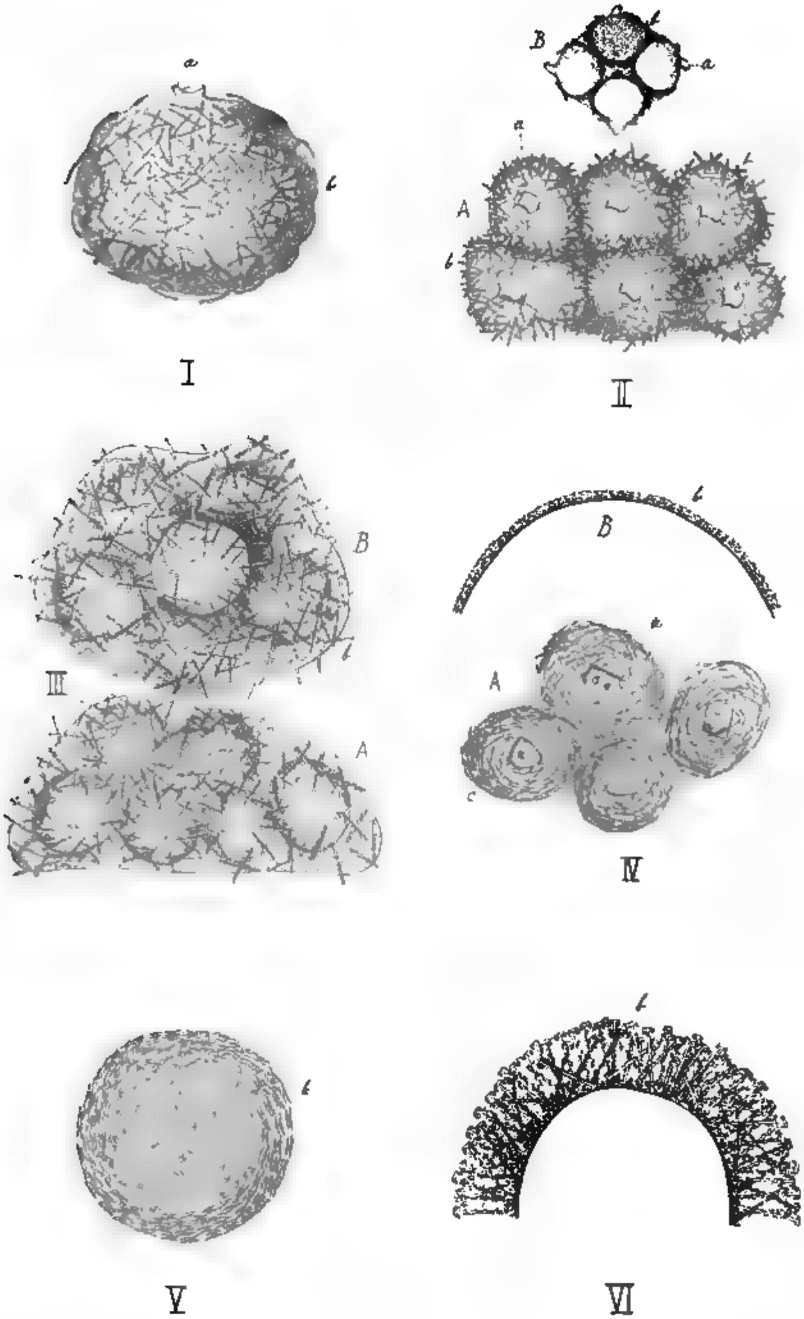


O. Meyer, del.

Meyer, Eocene Invertebrates



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POTTS ON FRESH WATER SPONGES.

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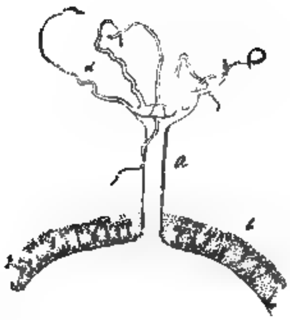

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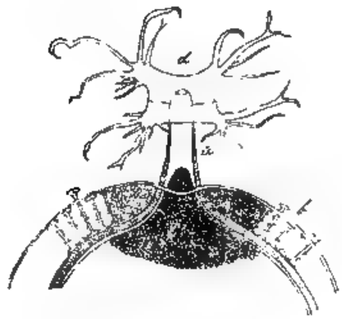

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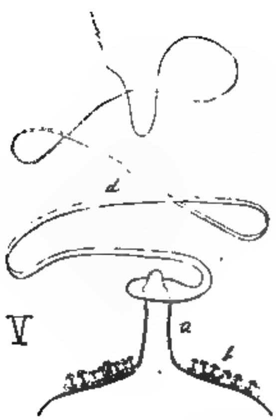

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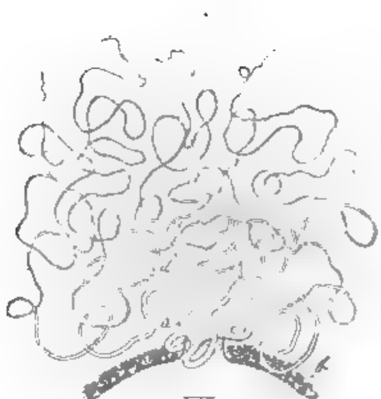

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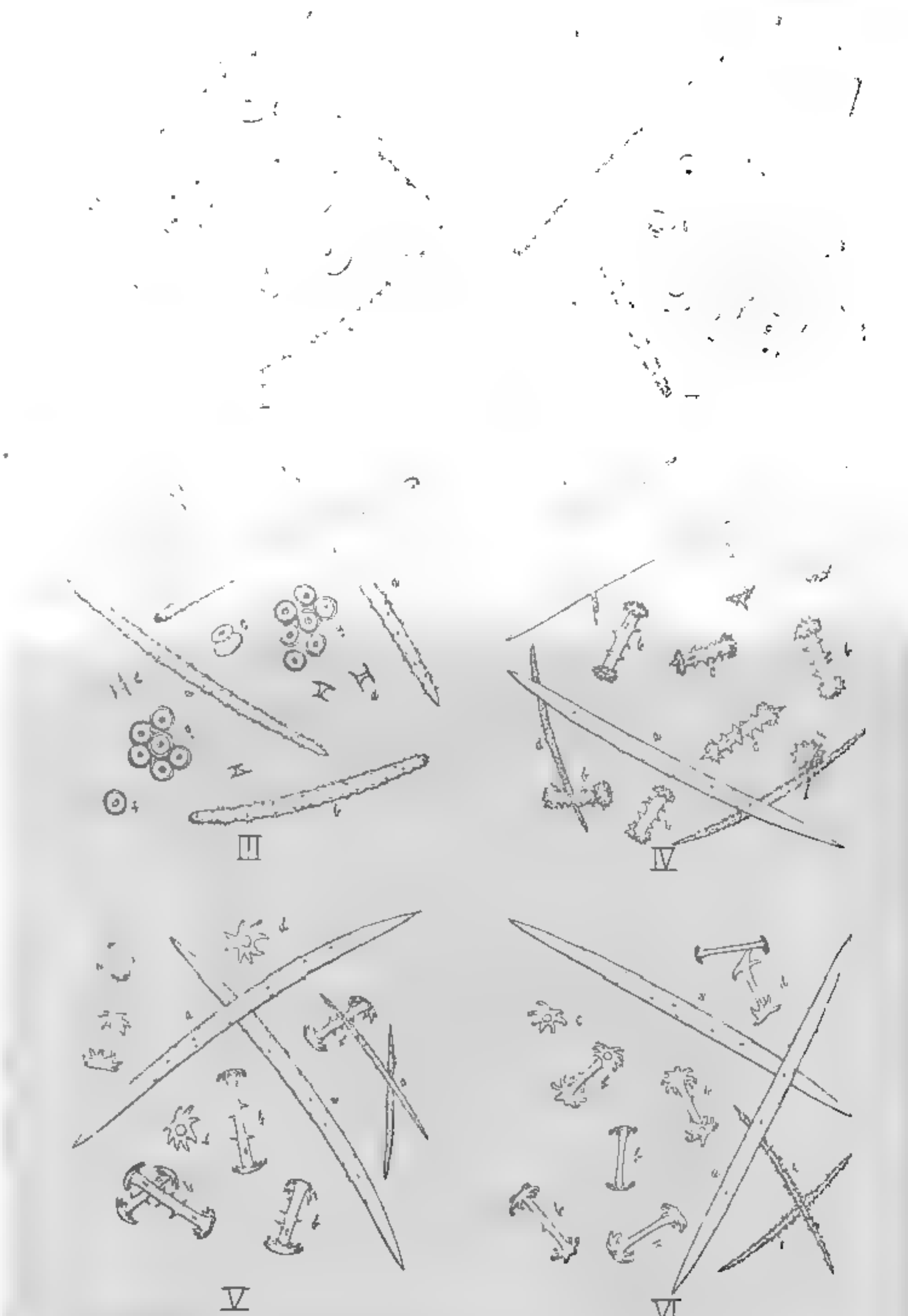

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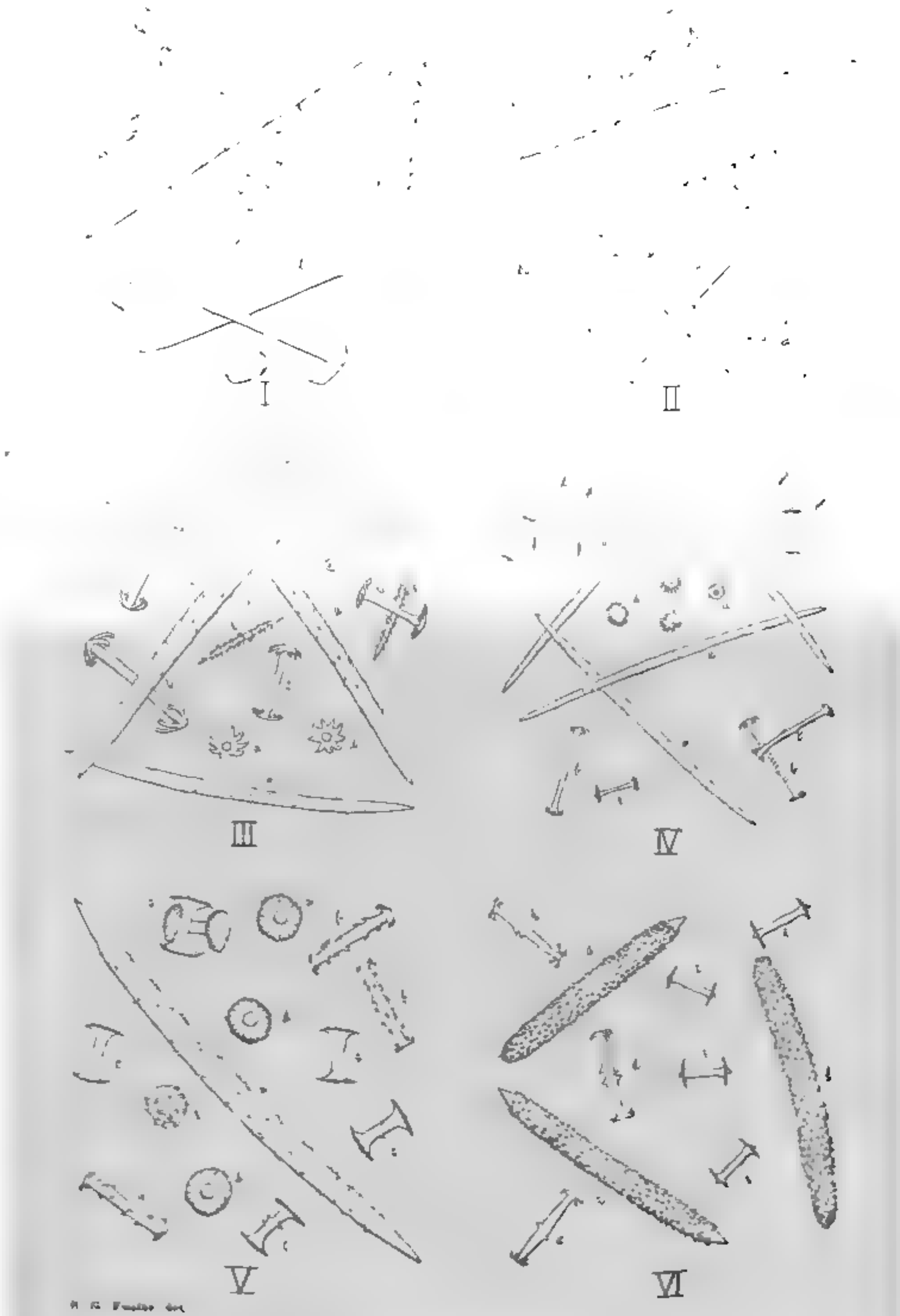

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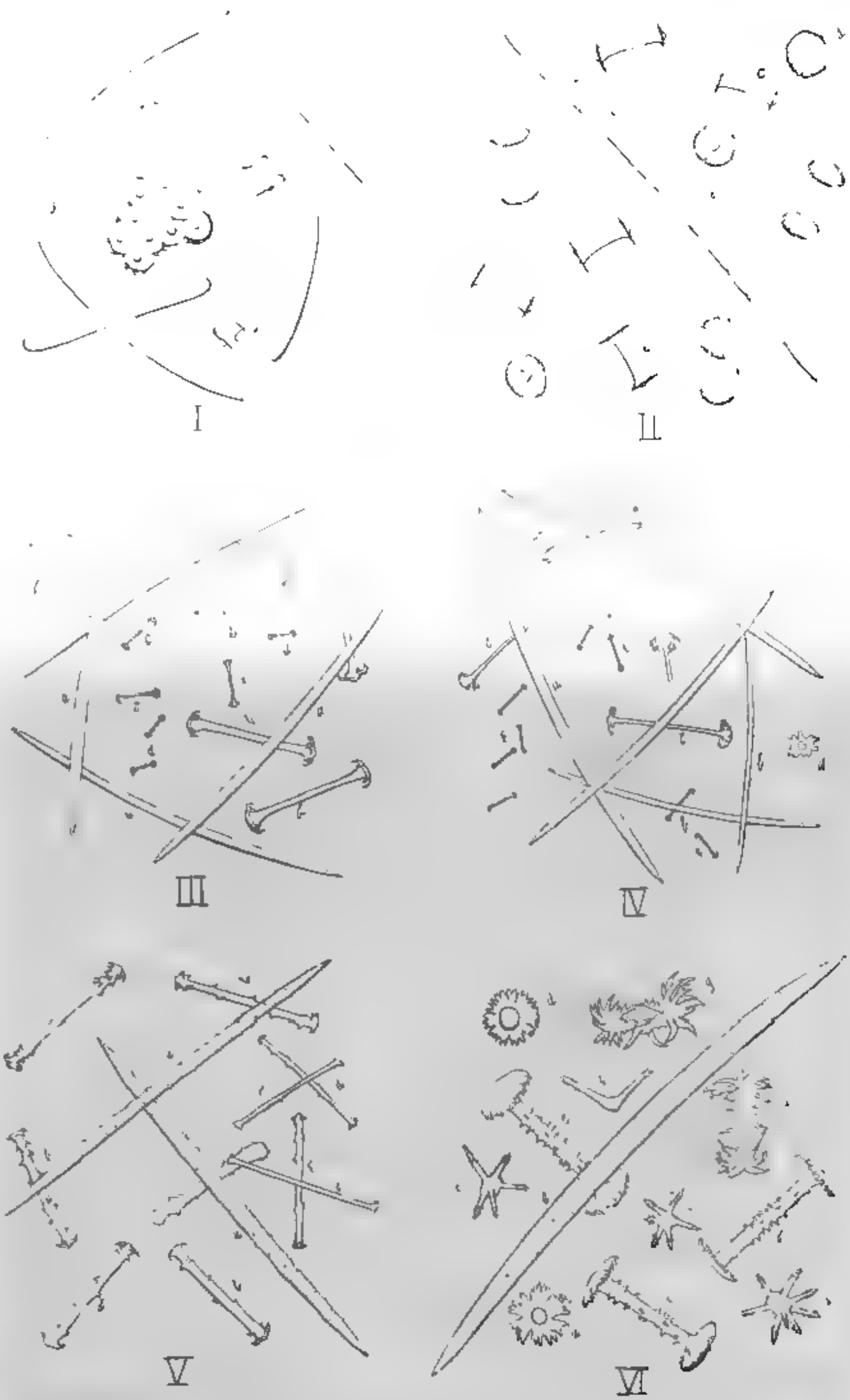

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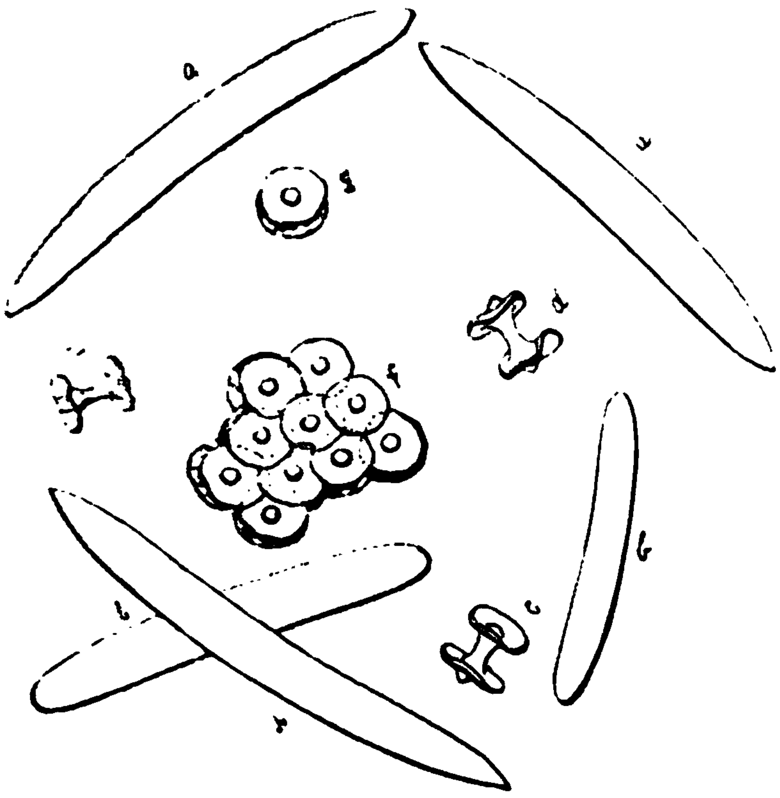

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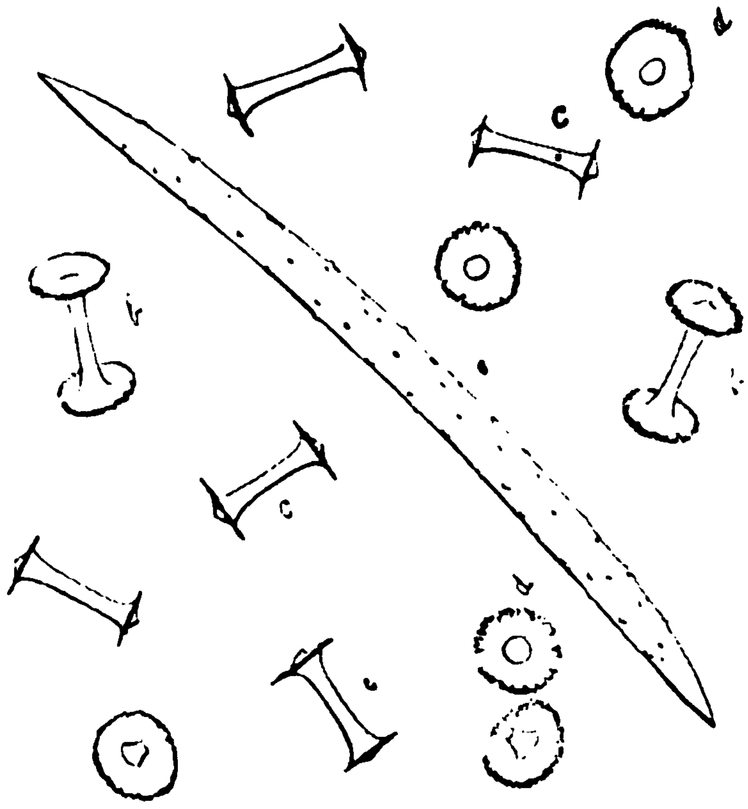

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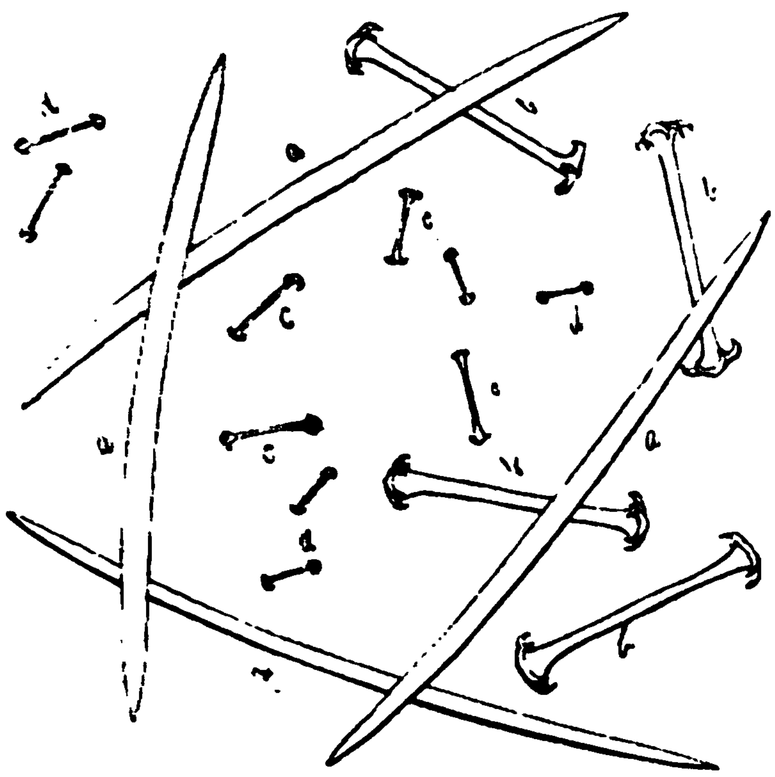

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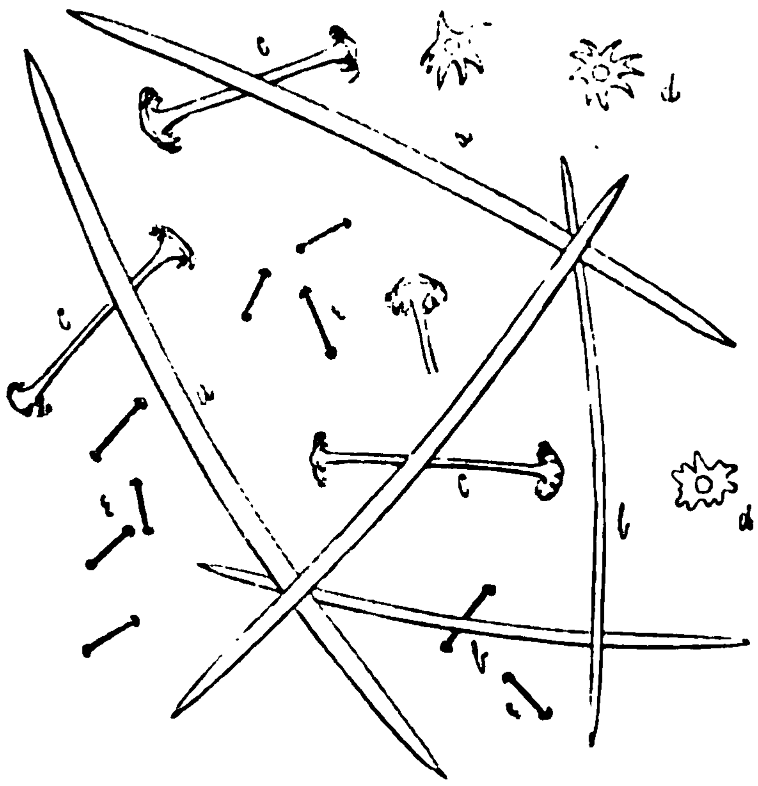

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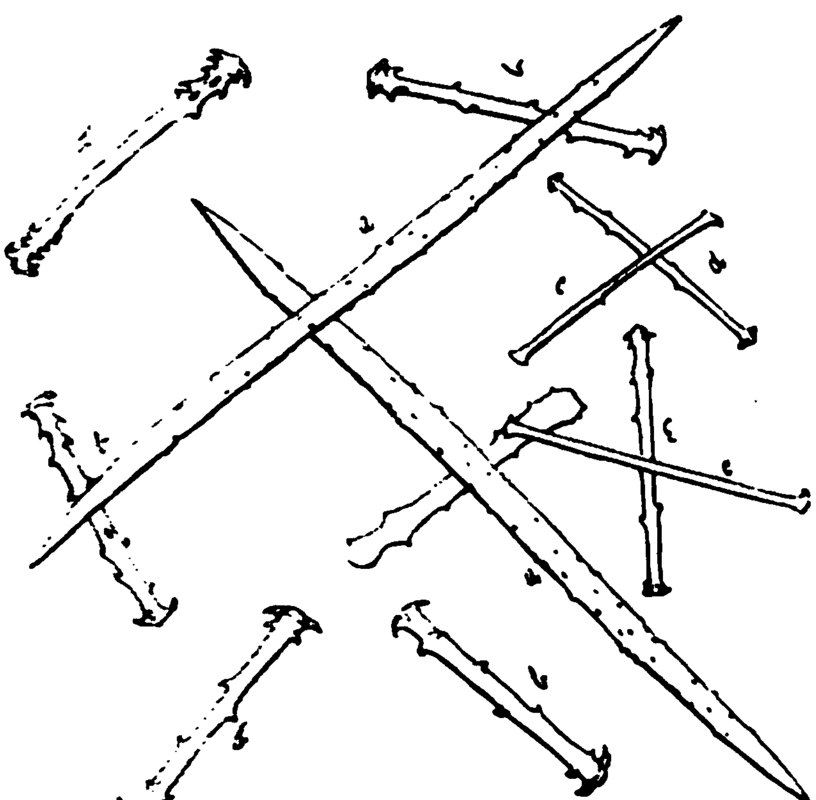

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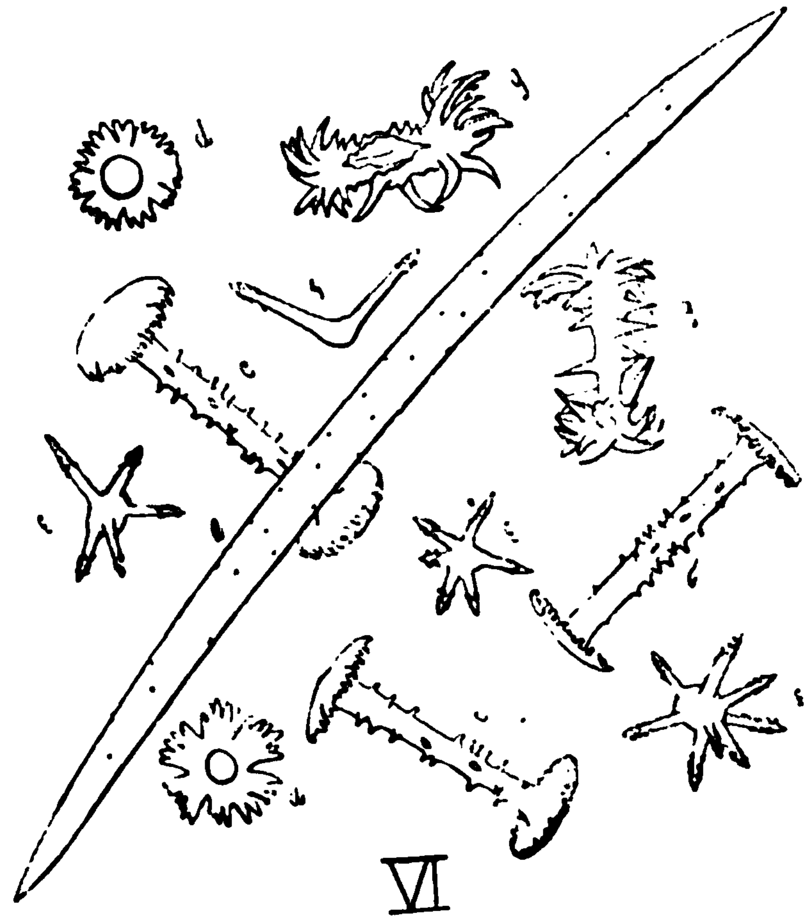

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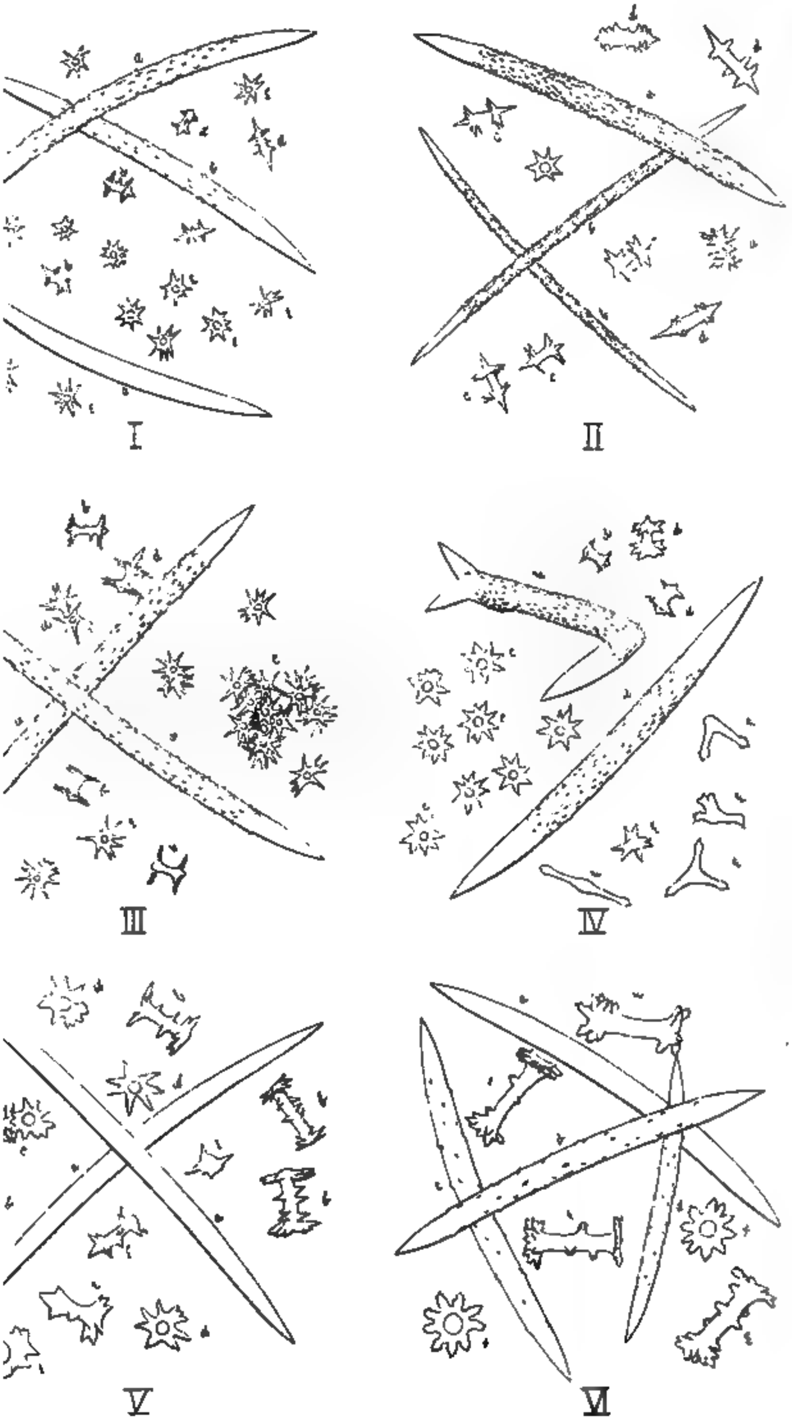

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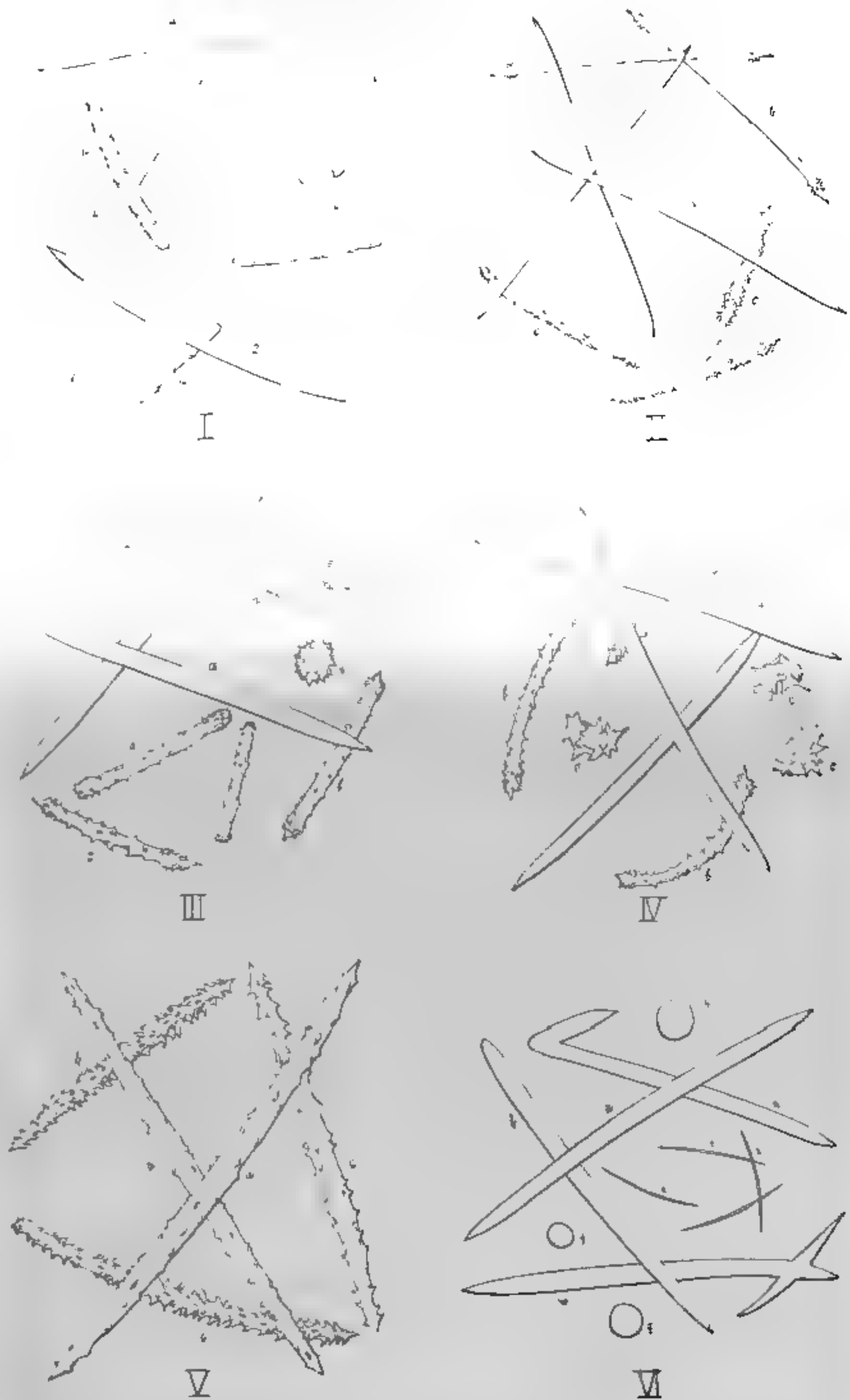

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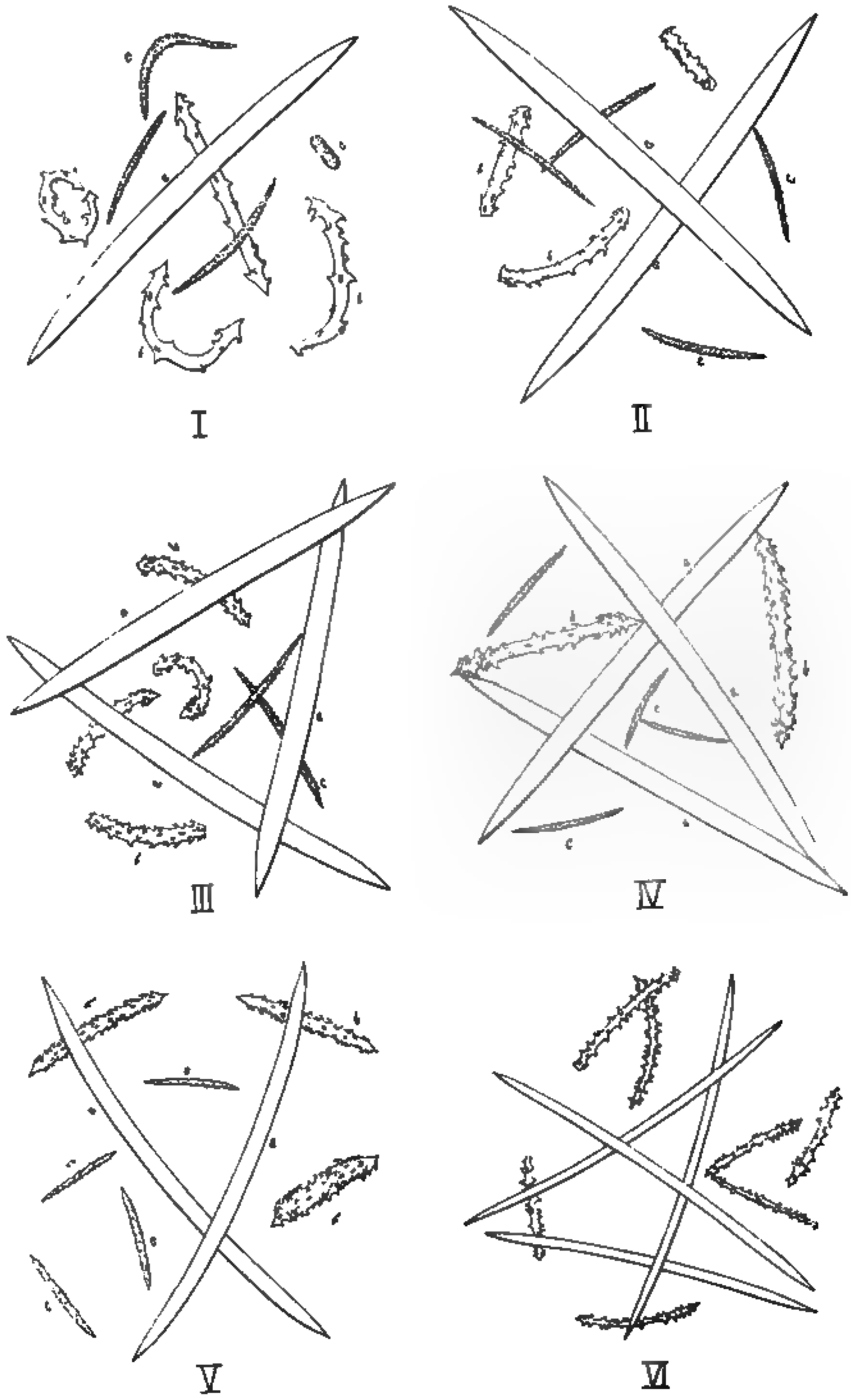

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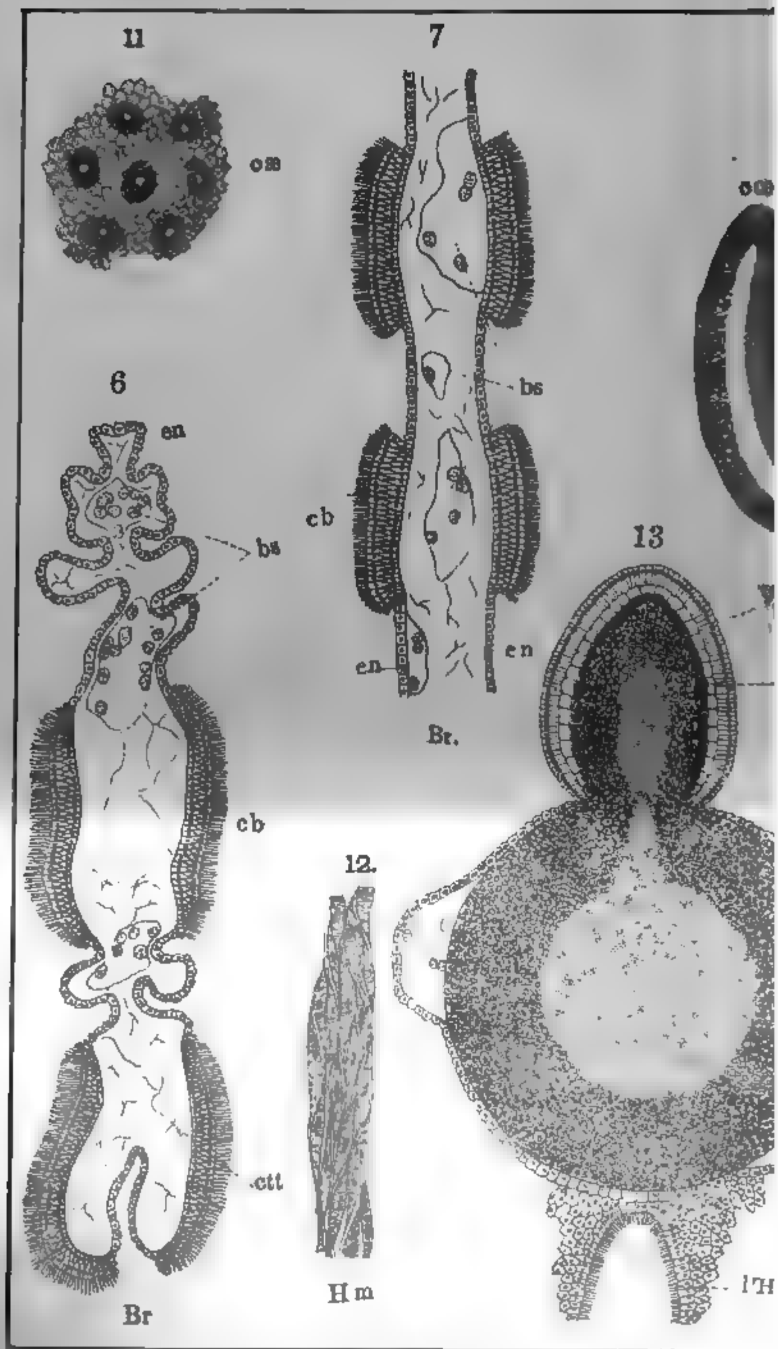
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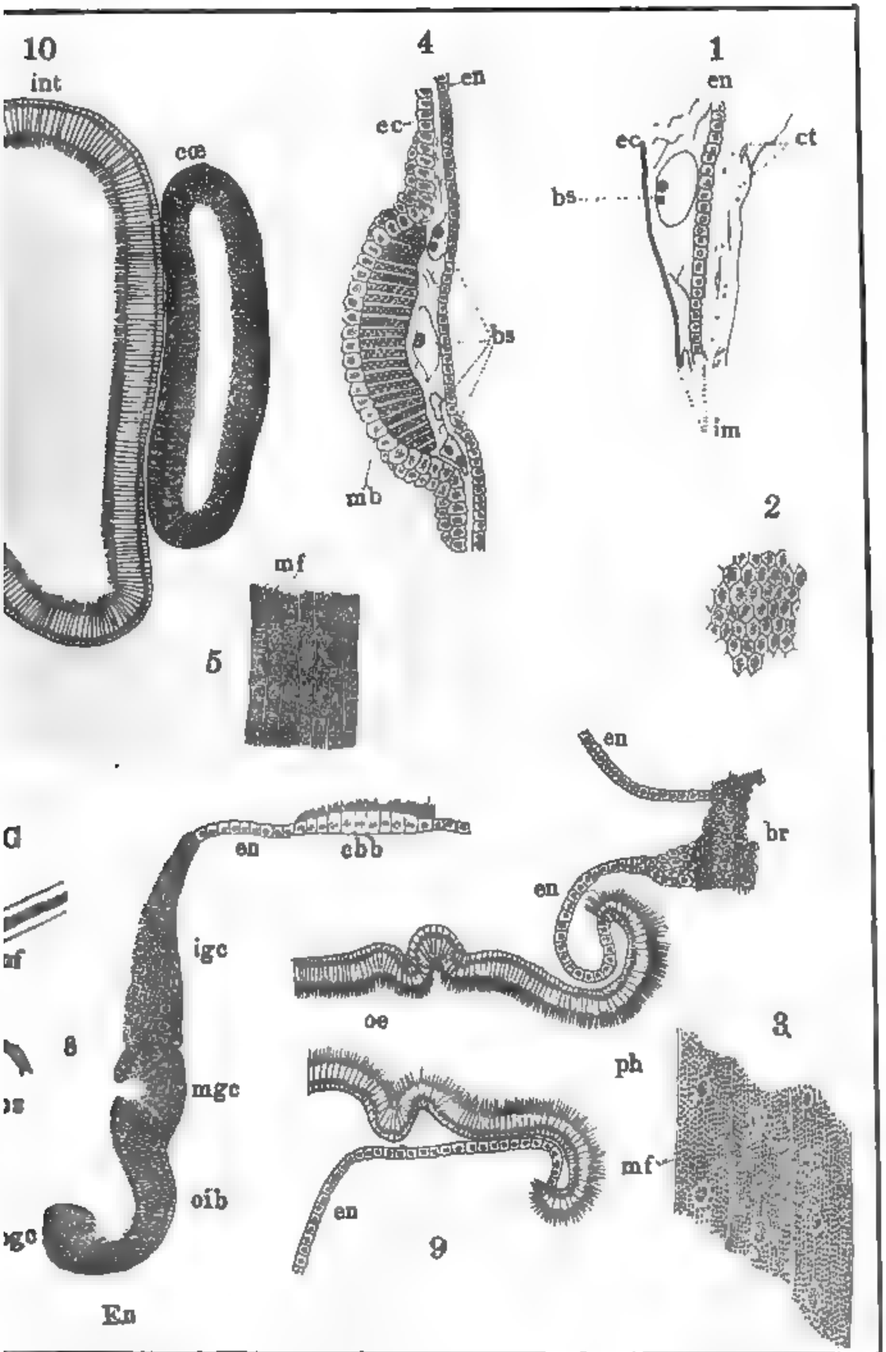
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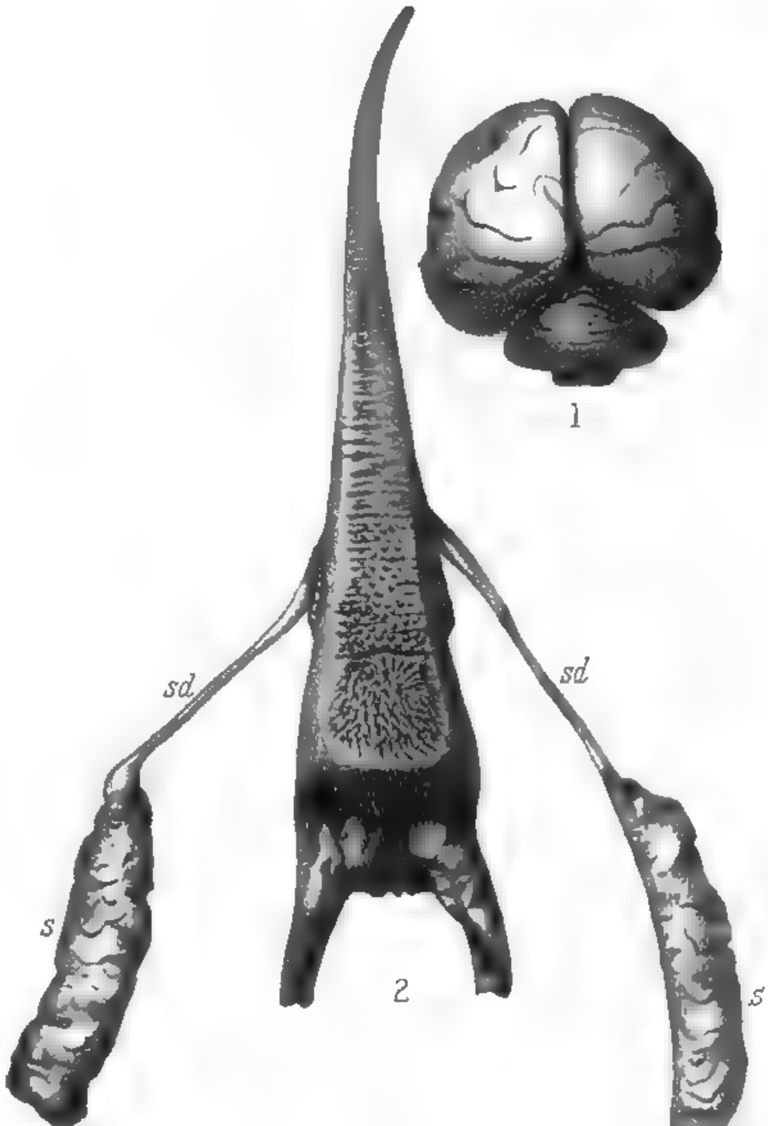

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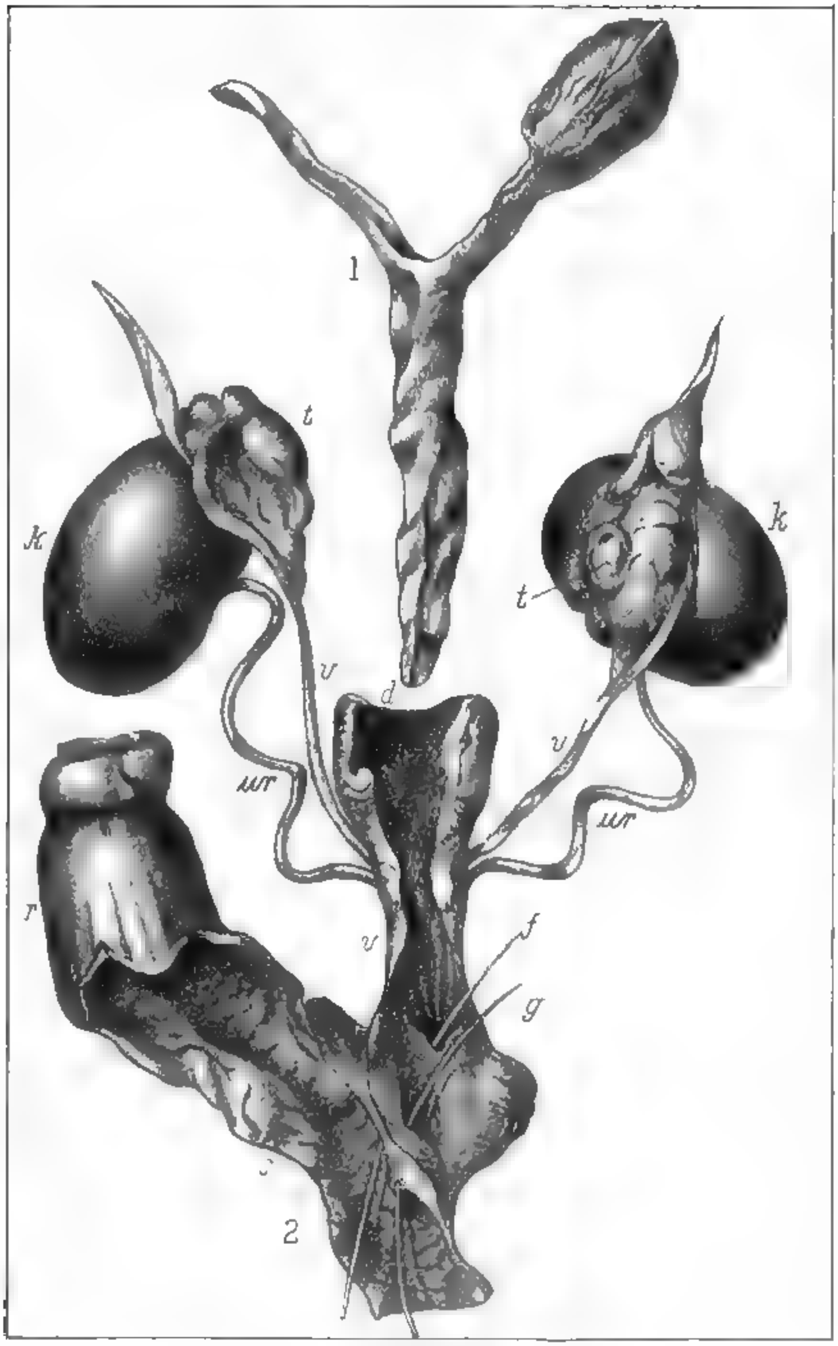

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